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Flexible and Mandatory Banking Supervision☆

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Abstract

Tighter regulation and more powerful supervision are being enacted after the global financial crisis. Although this trend may have positive welfare effects, it may also impose large social costs due to the strong reliance on supervisory information. We argue that offering banks a Flexible Supervision contract, designed to be chosen by those banks that will otherwise attempt to capture the supervisor, is a mechanism to implement the most efficient regulation under asymmetric information. The result that Flexible Supervision outperforms Mandatory Supervision remains robust to a series of extensions to our baseline model. Policy implications follow directly: Benevolent regulators should enact a Flexible Supervision regime for the less risky, more capitalized and transparent banks in addition to the traditional Mandatory Supervision regime.

Keywords: Banking Supervision, Regulatory Capture.
JEL: G21, G28.

1. Introduction

Tighter regulation and more powerful supervision of the financial sector are being implemented in most countries after the global financial crisis. Notable examples are the Dodd-Frank Act in the United States and the Capital Requirements Directive IV in Europe. Although the new rules may imply positive welfare effects, many commentators have stressed that they may also impose large social costs.[1] These costs may include legal and compliance direct costs, but also indirect costs which are related to the stronger reliance

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[1] See, for instance, *"Banks face pushback over surging compliance and regulatory costs"* on The Financial Times, May 28, 2015 and Cochrane (2014).

on supervisory information. Indeed, some of the measures being undertaken lead to a more intense supervision of banks and entail qualitative assessments of their organization and practices by the supervisor. A closer interaction of supervisees with more powerful supervisors and the reliance on supervisory information which is easy to conceal and difficult to be verified by third parties may backfire, paving the way for the capture of the supervisor by banks.[2]

In this paper, we develop a formal model that explicitly takes into account the possibility that banks capture the supervisor. Due to asymmetric information, a benevolent financial stability committee employs a supervisor to assess the banks' riskiness. The same asymmetric information problem opens the possibility that banks capture the supervisor so that the latter misreport supervisory information. In order to avoid capture, the financial stability committee needs to increase the salary of the supervisor and apply more stringent regulation to the riskier banks. As a result, the threat of supervisory capture implies a reduction in social welfare.

We propose a supervisory mechanism that dramatically reduces the social cost of implementing efficient bank regulation. More precisely, we show that this mechanism allows the financial stability committee to obtain the same outcome in terms of social welfare as when the supervisor is benevolent and therefore capture is not a concern. The mechanism consists of providing each bank with a menu of two alternative supervisory regimes. One of them involves direct supervision of the banks which then are regulated according to the outcome of the supervisor's assessment. We call this regime *Mandatory Supervision*. The other regime, that we call *Flexible Supervision*, allows the banks to bypass the supervisor's direct assessment, provided that they choose a certain regulatory contract. The optimal design of Flexible Supervision implies that only those banks which would otherwise have incentives to capture the supervisor decide to bypass supervision, while the others prefer mandatory supervision. Therefore, Flexible Supervision overcomes supervisory capture by reducing the interaction between supervisors and supervisees, without entailing any loss of information with respect to the case in which supervision is always Mandatory. This is because, under Flexible Supervision, the bank's choice of bypassing supervision reveals its private information.

Policy implications follow directly from the theoretical results: Benevolent financial stability committees should avoid the welfare costs due to the threat of supervisory capture by enacting a Flexible Supervision regime in addition to the traditional Mandatory one. Under these two regimes, the less risky banks are willing to signal their type by putting more capital at risk and being more transparent. In exchange, they are subject to a less stringent intervention by the supervisor which, in turn, reduces the scope for

[2]The phenomenon of regulatory/supervisory capture has been long studied (see, for example, the seminal work by Stigler, 1971) and its pervasiveness in the financial sector has often been documented (see Woodward, 2000, and the references therein). More recently, David Beim (*"Report on Systemic Risk and Bank Supervision"*, 2009) argues that the Federal Reserve Bank of New York was overly deferential to the banks being supervised and that such attitude could be seen as a (weak) form of supervisory capture (see David Beim's Testimony *"Before the Senate Committee on Banking, Housing and Urban Affairs Financial Institutions and Consumer Protection Subcommittee"*, November 21, 2014). Recent recordings of conversations among New York FED officials show that supervisors continue to adopt a non-confrontational style with the industry and are unwilling to speak up (see, for example, *"New Scrutiny of Goldman's Ties to the New York Fed after a Leak"* on The New York Times, November 19, 2014).

supervisory capture with welfare improving effects. This Flexible Supervision regime needs to be complemented with a more stringent, Mandatory Supervision regime applied to the rest of the banking system. Mandatory and Flexible Supervision may be interpreted as particular strategies in banking supervision. In practice, bank supervisors generally apply different supervisory strategies to banks according to their riskiness and other soundness indicators. Hence, the theoretical results in this paper provide a rationale for these kinds of supervisory strategies.[3]

Interestingly, the welfare gains stemming from the implementation of Flexible Supervision depend on the strength of the institutions. The weaker the institutional framework, the larger the gains due to Flexible Supervision. Moreover, the gains may be large even in those countries in which the institutional setting is strong but the banking lobby is extremely powerful and phenomena such as revolving doors allow banks to capture supervisors. Furthermore, even in those countries in which capture is a minor concern, Flexible Supervision may streamline regulation saving on compliance costs, thereby reducing the bureaucratic burden.

In the baseline model, a banker privately observes the riskiness of his bank. A benevolent financial stability committee, which can be thought of as an institution entrusted with the responsibility of designing banking regulation and the supervisory architecture so as to foster financial stability and maximize social welfare, does not observe the bank's riskiness. It may prefer, however, to use a supervisor in order to get this piece of information. The supervisory technology, though imperfect, can help in reducing the asymmetric information problem by generating evidence that is correlated with the bank's true level of risk.

If the supervisor is benevolent, then she does not need to be motivated to report truthfully the collected evidence because her incentives are aligned with those of the financial stability committee, i.e., to maximize social welfare. In this case, supervisory capture does not represent a threat and the second best solution can be achieved.[4] In contrast, if the supervisor is self-interested, she may be captured by banks. There are several reasons why supervisors may be willing to pursue other objectives than social welfare maximization.[5] For simplicity, we assume that the supervisor is interested in the payment she gets when reporting supervisory information to the financial stability committee. Since the supervisory technology

[3]Paragraph 43 of the *Guide to banking supervision* of the European Central Bank (see European Central Bank, 2014) provides a clear example of how supervisors use different strategies in practice: "The result of the SREP (Supervisory Review and Evaluation Process) is also a key input for the SSM (Single Supervisory Mechanism)'s strategic and operational planning. In particular, it has a direct impact on the range and depth of off-site and on-site activities that are carried out for a given institution." Regarding on-site inspections, paragraph 71 is more specific: "... The scope and frequency of on-site inspections are proposed by the JST (Joint Supervisory Team), taking into account the overall supervisory strategy, the SEP (Supervisory Examination Programme) and the characteristics of the credit institution (i.e. size, nature of activities, risk culture, weaknesses identified). ..."

[4]The first best solution cannot be achieved because asymmetric information determines that banks must get some information rents in order not to distort further efficiency.

[5]The reasons for a supervisor to be self-interested have been extensively discussed in the literature. For example, there might be reputation concerns as in Boot and Thakor (1993), the supervisor may be willing to protect local banks as in Carletti et al. (2015), or simply they are independent bodies receiving specific mandates.

is imperfect and the financial stability committee does not observe whether or not the supervisor has got information about the riskiness of the bank, then the supervisor is able to conceal supervisory information. Self-interest and the possibility to conceal information open the door for capture as some bankers may be better-off when no information is reported. These bankers may be willing to reward a supervisor who reports nothing to the committee. More precisely, we take the following modeling shortcut which is usual in the literature: Bankers may make side transfers to an informed supervisor to induce her to conceal evidence to the financial stability committee.

To prevent capture under the Mandatory Supervision regime, the financial stability committee must reward the supervisor when she provides evidence that may hurt bankers. In other words, the supervisor should be turned into a bounty-hunter, as in Tirole (1986), Laffont and Tirole (1991) and Kofman and Lawarree (1993). The salary of the supervisor should be such that she does not find it profitable to collude with a banker in order to conceal information. Given the interests at stake, this reward might be very large, thereby magnifying the distortions to the optimal regulatory policy that the committee may be able to implement. Hence, due to the threat of capture, social welfare will be lower than in the second best solution where the supervisor is benevolent. However, social welfare will be higher than in a situation without banking supervision.

The prevention of capture under Mandatory Supervision implies a transfer of information rents from bankers to the supervisor. In the limit, bankers are indifferent between capturing the supervisor and receiving a tighter regulation, i.e., their payoff will be the same. This observation sets the basis for an alternative supervisory arrangement that can forestall supervisory capture without social costs. We call this alternative arrangement Flexible Supervision and it works as follows. The financial stability committee offers the banker a regulatory contract which provides at least the same payoff he would obtain if the riskiness of his bank were assessed by a self-interested supervisor. If the banker self-selects this regulation, then there is no need for the supervisor's report because the financial stability committee can infer the characteristics of the bank from the banker's decision. As a result, Flexible Supervision will not involve any loss of information. Moreover, it will allow the financial stability committee to save the supervisor's reward in equilibrium and, in turn, to implement the second-best optimal regulatory policy.[6]

We analyze the robustness of the results to relaxing some of the assumptions of the baseline model. Flexible Supervision allows the implementation of the second-best optimal regulation, outperforming Mandatory Supervision, when we consider more than two levels of bank riskiness (as we do in the baseline model). This result also holds when the financial stability committee does not know the type of the supervisor, who can be either benevolent or self-interested and even can differ in the ability to learn the bank's level of risk. If supervisory information is soft, instead of hard as it is assumed in the baseline model, then the

[6]In addition to reduce the welfare costs due to the threat of supervisory capture, Flexible Supervision may also save on compliance and on-site supervision costs. We do not consider these costs in the model but they are sizable in the real world. Their inclusion in the model would not affect the qualitative results but it might make it optimal to induce the financial stability committee to use Flexible Supervision contracts more often.

supervisor-banker coalition can forge (and not only conceal) evidence to the financial stability committee. In this case, preventing all possible forms of capture is strictly more costly under Mandatory than under Flexible Supervision, i.e. the latter still outperforms the former in terms of social welfare. However, it is no longer possible to implement the second-best optimal regulation. Finally, the implementation of Flexible Supervision crucially depends on the fact that the supervisor and the banker cannot credible collude ex-ante, i.e. before the supervisory information is collected, providing a rationale for the usual practice of continuously reassigning supervisors to supervisees.

This paper contributes to the literature on the design of banking regulation and supervision. Many recent studies focus on the allocation of supervisory tasks to centralized and decentralized supervisors. Agur (2013) highlights how competition between bank regulators may have dire consequences in presence of regulatory arbitrage. Carletti et al. (2015) argue that centralizing supervision might have countervailing effect on banks' risk taking behavior. This occurs when local supervisors, which are biased towards domestic banks, are charged with collecting supervisory information.[7] Dell'Ariccia and Marquez (2006) compare two settings. One in which national regulators interested in their own domestic banking system set policies non-cooperatively and one in which an international regulator sets the same policy for the banks of all countries. Within this strand of the literature, our paper is most closely related to Boyer and Ponce (2012). They argue that splitting supervisory responsibilities between independent supervisory authorities is a superior institutional arrangement than concentrating responsibilities in a single authority when supervisory capture is a concern.[8] We use an extended version of their model to propose an alternative way to deal with the threat of supervisory capture, and conclude that the introduction of a flexible supervision contract allows to overcome capture and to implement efficient regulation without entailing any loss of information for the financial stability committee.

This paper is also linked to the agency theory of regulation (Laffont and Tirole, 1993). This strand of the literature typically proposes a compensation policy for the supervisor when providing evidence which is unfavorable to the agent so as to prevent corruption. Recent contributions develop alternative or complementary tools to overcome the threat of capture. Felli and Hortala-Vallve (2015) focus on rewarding whistle-blowing as a mechanism design tool to deter collusion and extortion within organizations. They show how the principal can benefit from enlarging the message space of both the supervisor and the agent allowing them to leak information about collusive agreements or blackmail threats. De Chiara and Livio (2015) show how the timing of the supervisor's report can be fruitfully used to minimize the cost of preventing corruption. The mechanism developed in this paper builds on that presented by Burlando and Motta (2015) in the context of the organization of a firm. They show that outsourcing can be the optimal organizational response to the threat of internal collusion. We apply a similar idea to the study of the optimal design of banking regulation and supervision showing how this may lead to a significant reduction of the social costs associated with supervisory capture. There are, however, some relevant modeling differences

[7] A conflict of interests between local and central supervisors is also analyzed by Colliard (2014).

[8] Boyer and Ponce (2012) build on the intuition first proposed by Laffont and Martimort (1999).

as we posit a different information structure which critically affects the feature of the optimal solution.[9]

The rest of the paper is organized as follows. In Section 2 we introduce the baseline model. Section 3 is devoted to the analysis of Flexible and Mandatory Supervision, we derive the main results of the paper and policy implications. In Section 4 we study several extensions and check the robustness of the results of the previous section. In Section 5 we make concluding remarks. Proofs and other technicalities are in Appendix A and B.

2. The Model

We consider a three-tier hierarchy consisting of a benevolent financial stability committee (FSC or it), a bank supervisor (she) and a banker (he). All parties are risk-neutral.

2.1. Banker

A banker has private information about the riskiness of the bank's assets r. The riskiness of a bank can be either low, $r = \underline{r}$, or high, $r = \bar{r}$, with $\underline{r} < \bar{r}$ and $Pr[r = \underline{r}] = \alpha \in (0, 1)$. The distribution of r is common knowledge.[10]

Following Boyer and Ponce (2012), we normalize to zero the amount of deposits in the bank and we denote by k the level of capital put at risk by the banker, which is equal to the size of the bank's balance sheet. The utility function of the banker is given by:

$$B = \pi - rk$$

where π is the bank's profit. The banker's reservation utility is such that $B \geq 0$.

2.2. Bank Supervisor

The financial stability committee may hire a self-interested bank supervisor to bridge its lack of information on the bank's riskiness. In order to motivate the supervisor to report the collected evidence, the FSC pays the supervisor a salary w. This salary can be made contingent on the report because the information reported can be verified. The supervisor's payoff must be sufficiently high so as to meet her reservation utility, which is normalized to zero, and we assume that she does not incur any effort cost to observe the bank's riskiness. We assume that the supervisor can quit at any time.[11] Therefore, the supervisor's participation constraint is:

$$S = w \geq 0 \tag{SPC}$$

[9]Specifically, the timing of information acquisition impacts on the design of the optimal contract and the sorting of the agents who choose to be supervised.

[10]The results of the baseline model are robust to consider more than two levels of risk, see Section 4.

[11]This would be equivalent to assuming that the supervisor is protected by limited liability.

2.3. Financial Stability Committee

The benevolent financial stability committee enacts regulation and designs supervision. In particular, the FSC (i) regulates the size of the bank's balance sheet, k, through capital regulation, mergers and acquisition regulation, downsizing policies and other tools; (ii) affects the profit of the bank, π, through tools such as taxes, fees, allowing or banning proprietary trading, capping the amount of loans the bank can issue or controlling interest rates[12] and (iii) designs ex ante the supervisory contracts and arrangements.

The costs of implementing bank regulation and supervision is captured by the assumption that the social cost of a dollar of public funds used to finance regulation π (i.e., to set the bank's profit) and the supervisor's salary w is $(1+\lambda) > 1$. This cost reflects the social losses that occur when taxes are imposed in one sector to finance other sectors of the economy.

The FSC maximizes the expected value of the following social welfare function:

$$W = \Psi(k) + B + S - (1+\lambda)(\pi + w)$$

where $\Psi(k)$ is the surplus that the customers of the bank derive from using its services. We assume that $\Psi'(\cdot) > 0$ to capture the fact that the customers' utility is increasing in the bank's size, as a larger bank is able to offer a wider range of financial products and services which better fit the customers' needs. We further assume that $\Psi''(\cdot) < 0$ since the marginal returns of an increase in the size of the bank are decreasing: Adding new products when the bank's offer is already quite large does not affect significantly the customers' utility. The welfare function can be rewritten as follows:

$$W = \Psi(k) - \lambda \underbrace{w}_{=S} - \lambda[\underbrace{\pi - rk}_{=B}] - (1+\lambda)rk$$

2.4. Information, Supervisory Technology and Report Possibilities

The supervisor collects information about the bank's riskiness through in situ inspections or by analyzing the bank's data. We assume that she observes a signal σ which provides conclusive information about the riskiness of the bank, i.e. $\sigma = r$, with probability $\varepsilon \in (0,1)$ and inconclusive information, i.e. $\sigma = \emptyset$, with probability $(1-\varepsilon)$. The assumption that supervision does not always generate conclusive evidence on the bank's true level of riskiness is due to the imperfect and multifaceted nature of inspections or analyzes of bank's data.

The supervisor sends a message m_s to FSC about the observed σ. We assume that the signal σ is a piece of hard information. This implies that σ is verifiable and that the supervisor is unable to falsify it with or without the bank assistance.[13] This implies that if $\sigma = \emptyset$, then $m_s = \emptyset$ while if $\sigma = r$, $m_s \in \{r, \emptyset\}$ because the supervisor can conceal supervisory information to the FSC. The banker also sends a report concerning the bank's level of risk, which we denote $m_b \in \{\underline{r}, \bar{r}\}$, and we assume that he can lie.

[12]Note that as a modeling shortcut we assume that π is fully determined by the FSC.

[13]In Section 4.2 we study a framework wherein supervisor and the banker can cooperate to forge false evidence, i.e., the signal is a piece of *soft information* in this case.

Information is nested along the hierarchy: the banker has the finest information set as he knows exactly the bank's riskiness and he is aware of the signal observed by the supervisor. The supervisor only observes σ while the FSC observes neither r nor σ but receives the supervisor's and the banker's messages, denoted m_s and m_b.

Based on r and σ, there are four possible states of nature:

1. $r = \underline{r}$ and $\sigma = r$, which occurs with probability $p_1 = \alpha\varepsilon$;
2. $r = \underline{r}$ and $\sigma = \emptyset$, which occurs with probability $p_2 = \alpha(1-\varepsilon)$;
3. $r = \bar{r}$ and $\sigma = \emptyset$, which occurs with probability $p_3 = (1-\alpha)(1-\varepsilon)$;
4. $r = \bar{r}$ and $\sigma = r$, which occurs with probability $p_4 = (1-\alpha)\varepsilon$.

Thus, the bank is low-risk in states 1 and 2 and high-risk in states 3 and 4, while the supervisor has conclusive information in states 1 and 4 and inconclusive information in states 2 and 3.

2.5. Contracts

A *regulatory-supervisory contract* designed by the FSC is a triplet $\{k(m_b, m_s), \pi(m_b, m_s), w(m_b, m_s)\}$. Although we do not allow the banker to send a message on the signal he observes along with the supervisor, we show in Appendix A that this is without loss of generality as it would not raise welfare.

If the banker accepts to be directly supervised, the banker and the supervisor can engage in a side-contract. The side-contract specifies the report the supervisor sends and a side-transfer from the banker to the supervisor, b, which is contingent on the supervisor's report. As discussed in the Introduction, bankers may have many reasons to capture their supervisors and may use a broad set of tools to do it. We use the side-transfer as a modeling shortcut. If the parties fail to agree on a side-contract the report is made non-cooperatively. As is customary in the literature on capture, side-contracts are assumed to be enforceable.[14] However, we assume that it is costly to organize the transaction and therefore we introduce the parameter $\tau < 1$ which is meant to capture such depreciation.[15] It is reasonable to suppose that τ is lower in those countries in which the institutional setting is stronger. Stronger institutions may imply more efficient courts of law and more watchful media. The former may be better able to detect capture and may punish more severely who commits this felony. The latter may curb the phenomenon of revolving doors, making it harder for a supervisor to join a bank that she has previously supervised.

2.6. Timing

The sequence of events is as follows:

[14] For a discussion of this assumption, see Tirole (1992).

[15] Note that often bribes do not take a monetary form so as to reduce the probability of being detected by the authorities. Namely, the banker may reward the supervisor through non-monetary gifts or favors and $1-\tau$ would be equivalent to the difference between the monetary cost of such bribe to the banker and their utility value to the supervisor. In what follows, we abstract from detection mechanisms, that is, if the supervisor colludes with the banker, the FSC does not discover the corruption activity.

1. The supervisor observes the signal. The banker learns the bank's riskiness and observes the supervisor's signal. The probability distributions are common knowledge.
2. The FSC simultaneously proposes a *regulatory-supervisory contract* to the supervisor and the banker. If one of them does not accept the contract, the game ends and all players receive their reservation utilities. If the banker accepts a Flexible Supervision contract, the bank's profit π and level of capital k will be contingent solely on m_b. If the banker accepts a Mandatory Supervision contract, the game continues as follows:
3. The banker and the supervisor can privately sign a side-contract.
4. The banker and the supervisor send their messages to the FSC. The regulatory-supervisory contract is implemented according to their reports.

2.7. Benchmarks

In what follows we solve for three benchmark cases: first, we consider a situation wherein FSC perfectly observes the riskiness of the bank, so that the first-best solution is attained; second, we consider a situation in which the objectives of the supervisor and the FSC are aligned, that is, the supervisor is benevolent and we characterize the second-best optimal solution; finally, we consider a situation wherein the supervisor is not available and FSC solves a traditional adverse selection problem inducing the banker to reveal the bank's riskiness through a direct revelation mechanism.

2.7.1. Benchmark 1: Symmetric Information - First-Best

When the FSC is perfectly informed about r, it can offer the banker a risk-specific contract in which (i) the participation constraint of the banker binds irrespective of the bank's riskiness, i.e. $\underline{\pi}^{fb} = \underline{rk}^{fb}$ and $\bar{\pi}^{fb} = \bar{r}\bar{k}^{fb}$; and (ii) the marginal cost of the level of capital put at risk by a banker equals the marginal utility derived by the customers of the bank, i.e. $\Psi'(\underline{k}^{fb}) = (1+\lambda)\underline{r}$ and $\Psi'(\bar{k}^{fb}) = (1+\lambda)\bar{r}$.

In such a situation, the social welfare is maximized and no rent is given up to a banker irrespective of his bank's riskiness: the first-best (*fb*) solution is attained.

2.7.2. Benchmark 2: Asymmetric Information

The two benchmarks considered in this section provide useful reference points to evaluate the beneficial impacts of Flexible Supervision.

Benevolent Supervisor - Second-Best. Consider now the benchmark case in which the FSC uses a benevolent supervisor to reduce the asymmetry of information. The FSC gets the supervisor's superior information at a zero cost, that is, by paying the supervisor a constant wage that equates her reservation wage. Therefore, $w_i = 0$ in all the states of the world. Yet, the FSC learns the bank's true riskiness with probability $\varepsilon < 1$ and, as a result, must give up some rent to the banker to induce truthful revelation of his private information.

When σ is informative (states 1 and 4), the FSC is perfectly informed about the riskiness of the bank. As a result, in state i, for $i \in \{1, 4\}$, the FSC maximizes

$$\max_{k_i,\pi_i} \Psi(k_i) - \lambda(\pi_i - r_i k_i) - (1+\lambda) r_i k_i$$

only subject to the supervisor's participation constraints (SPCi) and the banker's participation constraints:

$$\pi_i - r_i k_i \geq 0 \tag{PCi}$$

with $r_1 = \underline{r}$ and $r_4 = \bar{r}$. In equilibrium when the supervisor is benevolent (*bs*) the FSC manages to deprive the bank of its rent by setting $\pi_1^{bs} = \underline{r} k_1^{bs}$, $\pi_4^{bs} = \bar{r} k_4^{bs}$, $\Psi'(k_1^{bs}) = (1+\lambda)\underline{r}$, $\Psi'(k_4^{bs}) = (1+\lambda)\bar{r}$. Hence, since the FSC is fully informed the first-best solution is implemented in states 1 and 4: $\pi_1^{bs} = \underline{\pi}^{fb}$, $\pi_4^{bs} = \overline{\pi}^{fb}$, $k_1^{bs} = \underline{k}^{fb}$ and $k_4^{bs} = \overline{k}^{fb}$.

When σ is uninformative (states 2 and 3), the first-best contract is not feasible. As information is inconclusive, the riskiness of a bank is the banker's private information. In particular, if only a participation constraint were imposed in state 2, then a low-risk banker in state 2 would have an incentive to choose the contract designed for a high-risk banker in state 3. Hence, the FSC must ensure that the low-risk banker is unwilling to claim that the bank's level of risk is high by imposing the following *incentive compatibility* constraint:

$$\pi_2 - \underline{r} k_2 \geq \pi_3 - \underline{r} k_3 \tag{IC23}$$

In contrast the high-risk banker does not want to claim that his bank is low-risk, as he would bear a loss.[16] Yet, he must be induced to accept the supervisory-regulatory contract. Thus, the FSC imposes

$$\pi_i - r_i k_i \geq 0 \tag{BPCi}$$

for $i \in \{2, 3\}$.

The FSC solves:

$$\max_{k_2,k_3,\pi_2,\pi_3} \alpha[\Psi(k_2) - \lambda[\pi_2 - \underline{r} k_2] - (1+\lambda)\underline{r} k_2] \tag{1}$$
$$+ (1-\alpha)[\Psi(k_3) - \lambda[\pi_3 - \bar{r} k_3] - (1+\lambda)\bar{r} k_3]$$

subject to (IC23) and the participation constraints. The following Lemma characterizes the second-best solution.

Lemma 1. *The optimal contract when the supervisor is benevolent entails the following salaries for the supervisor: $w_i^{bs} = 0$ for $i = 1, 2, 3, 4$. The bank's profits are $\pi_1^{bs} = \underline{r} k_1^{bs}$, $\pi_2^{bs} = \underline{r} k_2^{bs} + \Delta r k_3^{bs}$, $\pi_i^{bs} = \bar{r} k_i^{bs}$ for $i = 3, 4$. The bank's required levels of capital at risk are such that $\Psi'(k_i^{bs}) = (1+\lambda)\underline{r}$ for $i = 1, 2$, $\Psi'(k_3^{bs}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}\lambda\Delta r$, $\Psi'(k_4^{bs}) = (1+\lambda)\bar{r}$.*

[16] If the high-risk banker chose the regulatory-supervisory contract designed for the low-risk banker, the level of capital that the FSC would require him to put at risk would be such that he would incur a loss.

Lemma 1 shows that optimal regulation under benevolent supervision entails more severe regulation for the most risky banks, that is:

1. high-risk banks face more stringent capital requirements than low-risk banks: $k_1^{bs} = k_2^{bs} > k_4^{bs} > k_3^{bs}$;
2. the banker of a low-risk bank may be strictly better off than the banker of a high-risk bank: $B_2^{bs} > B_i^{bs} = 0$ for $i \in \{1,3,4\}$.

The banker receives no rent in state 1, 3 and 4 and obtains a positive surplus in state 2, $B_2 > 0$, due to the incentive-compatibility constraint (IC23) that is binding. As the supervisor has not observed the bank's riskiness, the banker could pretend that his low-risk bank is in fact high-risk. To deter such behavior, the FSC must give up an informational rent to induce the banker to choose the regulatory contract which is socially optimal given his bank's level of risk. To reduce such rent, the FSC imposes more stringent capital requirements on the bank in state 3 than in the first-best solution. The level of capital put at risk is not distorted away from efficiency in the other states of nature and low-risk banks face less severe capital regulation than high-risk banks. Note also that the supervisor need not be provided an informational rent to reveal the information she has gathered about the bank's riskiness because we assumed that she is benevolent.

No Supervision. In the absence of supervision and in the presence of asymmetric information about r, the FSC sets up a direct revelation mechanisms wherein regulation is based on the announcement of its riskiness. The bank's contract is either $(\underline{k}, \underline{\pi})$ if it announces that it is low-risk or $(\bar{k}, \bar{\pi})$ if it announces that it is high-risk. To discourage a low risk-bank to mimic a high-risk bank, the FSC must impose the following incentive compatibility constraint:

$$\underline{\pi} - \underline{r}\underline{k} \geq \bar{\pi} - \underline{r}\bar{k} \qquad (\underline{IC})$$

For the high-risk bank, the relevant constraint is the participation constraint:

$$\bar{\pi} - \bar{r}\bar{k} \geq 0 \qquad (\overline{PC})$$

The program the FSC maximizes can be written as:

$$\max_{\underline{\pi},\bar{\pi},\underline{k},\bar{k}} \alpha[\Psi(\underline{k}) - \lambda(\underline{\pi} - \underline{r}\underline{k}) - (1+\lambda)\underline{r}\underline{k}] + (1-\alpha)[\Psi(\bar{k}) - \lambda(\bar{\pi} - \bar{r}\bar{k}) - (1+\lambda)\bar{r}\bar{k}] \qquad (2)$$

subject to $(\overline{PC})$ and $(\underline{IC})$.

The following lemma summarizes the result:

Lemma 2. *In the optimal no supervision contract (ns), the bank's profits are* $\bar{\pi}^{ns} = \bar{r}\bar{k}^{ns}$ *and* $\underline{\pi}^{ns} = \underline{r}\underline{k}^{ns} + \Delta r\bar{k}^{ns}$, *where* $\Delta r = \bar{r} - \underline{r}$. *The bank's required levels of capital at risk are such that* $\Psi'(\underline{k}^{ns}) = (1+\lambda)\underline{r}$ *and* $\Psi'(\bar{k}^{ns}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}\lambda\Delta r$.

The high-risk banker does not receive a rent in equilibrium, i.e. $\bar{B} = 0$, while the low-risk banker collects a positive rent, $\underline{B} > 0$, which is increasing in the difference in the riskiness of the two types of bank, that we have denoted $\Delta r = \bar{r} - \underline{r}$. As the FSC attempts to reduce the rent given up to the low-risk banker, the level of capital at risk required from the high-risk bank is distorted downwards relative to the first-best one and the magnitude of such distortion negatively depends on the fraction of high-risk banks. By contrast, the low-risk bank's capital at risk is not distorted as it has no impact on the rent paid by the FSC.

Comparison. The benefits of benevolent supervision are apparent. The banker collects a rent only if his bank is low-risk and this has not been discovered by the supervisor. Stated differently, he receives a positive surplus only in state 2 and not also in state 1 as when a supervisor is not available. In addition, the high-risk bank capital is distorted downwards only in state 3 and not also in state 4 thanks to the additional information provided by the supervisor. Otherwise stated since the use of a benevolent supervisor reduces the information rents to the banker at no additional cost for the FSC, welfare is higher under benevolent supervision than under absence of supervision, i.e. $W^{bs} > W^{ns}$.

3. Flexible and Mandatory Supervision

In this section we derive the optimal regulatory contract when the supervisor is self-interested and may be captured by the banker. We use a modeling shortcut by representing capture as a transfer from the banker to the supervisor to induce the latter to conceal conclusive evidence to the FSC. We first analyze a standard setting in which banking supervision is always used and the regulatory contract always entails a report sent by a supervisor. We call this supervisory option *Mandatory Supervision*. Then, we explore a regulatory option in which the bank is presented with the opportunity of bypassing the supervisory scrutiny. We call this alternative institutional setting *Flexible Supervision*. With this arrangement the banker can accept a regulatory profile that requires a certain level of capital at risk without being subjected to supervision. Finally, we evaluate these arrangements in terms of welfare.

3.1. Mandatory Supervision

Consider an institutional arrangement in which the supervisor is always engaged to report on the bank's riskiness. With Mandatory Supervision the FSC offers the banker and the supervisor a menu of regulatory-supervisory contracts that specify capital requirements, profits and salaries as functions of the messages.

Since the supervisor can act opportunistically, the solution illustrated in the previous section can no longer be implemented, since the banker and the supervisor would engage in a lucrative collusive agreement. This would happen when the bank is low-risk and the signal is informative about the bank's riskiness, that is in state 1. The banker would have an incentive to convince the supervisor to send an uninformative report so that the FSC is uninformed and the banker can earn an information rent.

We now set out the optimal capture-proof contract, namely the optimal scheme which prevents collusive agreements in equilibrium and motivate the supervisor to report truthfully the information she collects. In the proof of Lemma 3 we establish that restricting attention to capture-proof schemes is without loss of generality.[17]

Note that the maximum side-transfer the banker is willing to pay to induce the supervisor to report $m_s = \emptyset$ when $\sigma = \underline{r}$ is equal to the difference between his payoff in state 2 and that in state 1, namely $B_2 - B_1$. Recall however that each side-transfer b paid by the banker increases the supervisor's utility by only $b\tau$, with $\tau \in (0,1)$. Moreover, when the supervisor reports $m_s = \emptyset$, she foregoes salary w_1 and receives instead salary w_2 from the FSC. Therefore, the supervisor is willing to conceal information in state 1 if and only if $w_2 + b > w_1$. The following capture-incentive compatibility (CIC) constraint must then be imposed to ensure truthful-reporting:[18]

$$w_1 - w_2 \geq \tau[B_2 - B_1] \tag{CIC}$$

The FSC maximizes the following objective function

$$W = \sum_{i=1}^{4} p_i(\Psi(k_i) - \lambda w_i - \lambda(\pi_i - r_i k_i) - (1+\lambda) r_i k_i) \tag{3}$$

subject to (CIC), $(IC23)$, $(SPCi)$ and (PCi) for all $i = 1,2,3,4$.

The following lemma characterizes the optimal capture-proof contract:

Lemma 3. *The optimal capture-proof contract under Mandatory Supervision (ms) entails the following salaries for the supervisor:* $w_i^{ms} = 0$ *for* $i = 2,3,4$, $w_1^{ms} = \tau \Delta r k_3^{ms}$. *The bank's profits are* $\pi_1^{ms} = \underline{r} k_1^{ms}$, $\pi_2^{ms} = \underline{r} k_2^{ms} + \Delta r k_3^{ms}$, $\pi_i^{ms} = \bar{r} k_i^{ms}$ *for* $i = 3,4$. *The bank's required levels of capital at risk are such that* $\Psi'(k_i^{ms}) = (1+\lambda)\underline{r}$ *for* $i = 1,2$, $\Psi'(k_3^{ms}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}\frac{1-\varepsilon(1-\tau)}{1-\varepsilon}\lambda \Delta r$, $\Psi'(k_4^{ms}) = (1+\lambda)\bar{r}$.

Lemma 3 shows how the bank's regulation and the supervisor's compensation are affected by the possibility of capture under the Mandatory Supervision regime. As compared to the benevolent supervisor case, the Mandatory Supervision solution entails a more severe regulatory scheme for high-risk banks in state 3, namely $k_3^{ms} < k_3^{bs}$ and $\pi_3^{ms} < \pi_3^{bs}$. The reason is the following. When capture is a concern, the FSC has to reward the supervisor to achieve truthful-reporting in state 1. The size of this reward is linked to the maximum transfer the banker is willing to do in order to induce the supervisor to conceal evidence in that state. By tightening the capital requirements of the high-risk banks in state 3, the FSC gives up a smaller informational rent to the banker in state 2, thereby minimizing the stake for collusion and in turn the social cost of acquiring information.[19]

Lemma 3 highlights how preventing capture is not without costs when supervision is mandatory. As compared to the benevolent supervisor benchmark, inducing truthful revelation involves a higher distor-

[17] We also prove that the FSC cannot gain from more complex mechanisms which, for instance, entail a bank's announcement about σ.

[18] Implicit is the assumption that the supervisor reports evidence truthfully when indifferent.

[19] It is also worth noting that the stake for collusion is greater the larger is τ. This implies that there are benefits from pursuing policies which make it more difficult for the parties to exchange side-payments. These are policies which make courts of law more effective so as to increase the likelihood that such side transactions are detected and the parties involved prosecuted. Additionally, also those campaigns which raise the civil servants' awareness of the dire social consequences of engaging in opportunistic behaviors can increase the moral cost that supervisors incur if they collude with the banks.

tion to the size of the high-risk banks and a higher cost of supervision. Together these distortions reduce the welfare with respect to the second best: $W^{ms} < W^{bs}$.

3.2. *Flexible Supervision*

We now illustrate an alternative institutional arrangement in with rather than just presenting the banker and the supervisor with a menu of regulatory-supervisory contracts, the FSC also offers the banker the option of accepting a specific regulatory scheme (k_0, π_0) without being subjected to a supervisory assessment. In this case, we say that the FSC proposes a menu of regulatory options that that induces Flexible Supervision.

The intuition as to why Flexible Supervision may be welfare improving can be easily illustrated. If we compare the solutions when the supervisor is benevolent and when she is self-interested, we observe that the banker continues to receive a rent of $\Delta r k_3$ only in state 2. In contrast, it is the supervisor who benefits from the possibility of being captured as she collects a rent in state 1 equal to $\tau \Delta r k_3$. As the banker does not receive any rent in state 1, the FSC can costless induce him to opt for an alternative regulatory option. This alternative regulatory option can just guarantee the banker the same utility he would obtain if he accepted to be scrutinized by a supervisor. Since now the supervisor's report does not provide further information to the FSC in state 1, the latter does not need to compensate the former for her report. Otherwise stated, if the banker accepts the Flexible Supervision contract he is signaling his riskiness to the FSC, as a consequence the supervisor's report is not needed and she does not receive any payment.

In this richer setting there are five contractual options: 1 to 4 refer to the same regulatory-supervisory contracts discussed before while contract 0 refers to the Flexible Supervision contract.[20] Having this menu of regulatory options involves further constraints which reflect the willingness of the FSC to ensure that the banker chooses Flexible Supervision in state 1. To this end, the following incentive-compatibility constraint is set:

$$\pi_0 - \underline{r}k_0 \geq \pi_1 - \underline{r}k_1 \tag{IC01}$$

This condition ensures that a banker who knows that the supervisor has learn that his bank is low-risk is (weakly) better off choosing not to be supervised. The FSC also wants the contract to be separating so that neither a low-risk bank in state 2 (i.e., when the supervisor is not informed about the riskiness of the bank) nor a high-risk bank (in both states 3 and 4) are willing to choose the Flexible Supervision contract. To this end, the following collection of incentive compatibility constraints is imposed:

[20] Note that while $1, ..., 4$ refer to both the contractual options and the states of the world, 0 only refers to the Flexible-Supervision contract.

$$\pi_2 - \underline{r}k_2 \geq \pi_0 - \underline{r}k_0 \tag{IC20}$$

$$\pi_3 - \bar{r}k_3 \geq \pi_0 - \bar{r}k_0 \tag{IC30}$$

$$\pi_4 - \bar{r}k_4 \geq \pi_0 - \bar{r}k_0 \tag{IC40}$$

The FSC maximizes the following objective function:

$$\max_{k_i,\pi_i,w_i,i\in\{0,2,3,4\}} \alpha\varepsilon[\Psi(k_0 - \lambda(\pi_0 - \underline{r}k_0) - (1+\lambda)\underline{r}k_0] + \sum_{i=2}^{4} p_i[\Psi(k_i) - \lambda(\pi_i - r_i k_i) - (1+\lambda)r_i k_i - \lambda w_i] \tag{4}$$

subject to (PCi), (SPCi), (IC23), (IC01), (IC20), (IC30), (IC40), (CIC), $i \in \{0,1,2,3,4\}$. Proposition 1 states the main contribution of the paper. It characterizes the optimal contract when supervision is flexible.

Proposition 1. *Optimal Flexible Supervision (fs) entails the following profits and capital requirements in equilibrium:* $\pi_0^{fs} = \underline{r}k_0^{fs}$, $\pi_2^{fs} = \underline{r}k_2^{fs} + \Delta r k_3^{fs}$, $\pi_3^{fs} = \bar{r}k_3^{fs}$, $\pi_4^{fs} = \bar{r}k_4^{fs}$, $\Psi'(k_0^{fs}) = \Psi'(k_2^{fs}) = (1+\lambda)\underline{r}$, $\Psi'(k_3^{fs}) = (1+\lambda)\bar{r} + \frac{\alpha\lambda\Delta r}{1-\alpha}$, $\Psi'(k_4^{fs}) = (1+\lambda)\bar{r}$. *The supervisor is paid* $w_i = 0$ *for all* $i \in \{0,2,3,4\}$.
Off-the-equilibrium path, $\pi_1^{fs} = \pi_0^{fs}$, $w_1^{fs} = \tau\Delta r k_3^{fs}$, $k_1^{fs} = k_0^{fs}$.

Proposition 1 shows that regulatory capture can be deterred at no cost with Flexible Supervision since the banker of the low-risk bank is induced to choose the Flexible Supervision contract is state 1. As a result, the distortion of the capital requirement imposed on the high-risk banks in state 3 is reduced with respect to the Mandatory Supervision option. It is important to stress that this mechanism is sustained by the FSC's promise to pay the supervisor a reward $w_1 = \tau\Delta r k_3^{fs}$ off-the-equilibrium path. If $w_1 < \tau\Delta r k_3^{fs}$, then in state 1 the banker would prefer to be subjected to supervision, anticipating that he could strike a mutually beneficial agreement with the supervisor.

The intuition behind the welfare improving effects of Flexible Supervision is as follows: To minimize the dire consequences of regulatory capture, the screening of the riskiness of banking institutions does not necessarily require the involvement of a supervisor. Those banks which would have an incentive to capture a supervisor, namely those banks that could be certified as low-risk by a supervisor, should not be subjected to supervision and they should be able to opt for a self-certification of their riskiness. By doing so, the FSC would not need to pay a substantial reward to prevent regulatory capture. In turn, it would not need to distort downwards the capital invested by banks.

Moreover, it is worth noting that although banks are not always subjected to supervision, preventing regulatory capture through Flexible Supervision does not entail any loss of information. In other words, through this institutional arrangement, the FSC can elicit the same information as when supervision is mandatory, without incurring any cost to deter regulatory capture. It follows that Flexible Supervision enables the FSC to achieve the same outcome as in the benevolent supervisor benchmark:

Corollary 1. *Optimal Flexible Supervision achieves the second best outcome:* $W^{bs} = W^{fs} > W^{ms}$.

Moreover, it is worth pointing out that the second-best outcome is achieved irrespective of the quality of the institutional setting, namely, for all values of τ. It follows that higher gains from implementing Flexible Supervision can be achieved in those countries characterized by weak institutions or by the presence of a powerful banking lobby because the social cost of the distortions introduced by Mandatory Supervision in order to avoid capture increase with τ (see Lemma 3).

Another important feature of Flexible Supervision is that it allows banks to choose whether or not to be subjected to supervision, which in turn allows some sorting of banks. In particular, the banks that would be subjected to supervision would be characterized by either a high or a low level of risk, while banks that would decide to bypass supervision would always have a low-risk profile. This fact has implications when considering a different timing of the model. Specifically, it does not matter if the FSC proposes the contract to the banker and the supervisor sequentially rather than simultaneously, as in the baseline model. If the banker opts for supervision, the FSC cannot infer with certainty whether the bank is high or low risk and finds it optimal to employ the supervisor to collect additional information.

It also has implications when considering some positive and small supervisory cost. Then, implementing Flexible Supervision would generate additional benefits as it would allow to screen the banks saving this supervisory cost in some states of nature. In state 1 the FSC would induce the banks not to be subjected to supervision so as to save the rent paid to the supervisor as well as the cost of supervision.

3.3. Policy Implications

The previous theoretical results imply that the second best outcome may be implemented via the introduction of a Flexible Supervision contract. Otherwise stated, when the supervisor is self-interested and her capture by the industry is a concern, then Flexible Supervision allows the achievement of the same outcome that would be obtained under benevolent supervision; i.e. given the asymmetry of information, social welfare is maximal under Flexible Supervision. This provides a rationale for enacting Flexible Supervision in practice.

Mandatory and flexible supervision may be interpreted as particular strategies in banking supervision. In practice, bank supervisors generally apply different supervisory strategies to banks according to their riskiness and other soundness indicators. In general, riskier, more opaque and less capitalized banks deserve more attention by supervisors, with more on-site inspections and relatively more resources dedicated to their supervision. One could associate this kind of supervisory regime with Mandatory Supervision. In this case, the focus of attention is on the application of the right regulation and requirements according to the characteristics of banks. Alternatively, less risky, more transparent and well capitalized banks are more likely to being supervised on distance (through what is called off-site supervision) and with a compliance focus, where supervision is less stringent as long as banks fulfill certain criteria. This kind of supervisory regime may be associated with what is called flexible supervision in this paper.

Indeed, when the Flexible Supervision contract is introduced in the model, then only the less risky (i.e. $r = \underline{r}$), more capitalized banks (in particular those banks with the highest level of capital, i.e. k_0^{fs} such that $\Psi'(k_0^{fs}) = (1+\lambda)\underline{r}$)) and those banks that do not get any information rent because $\pi_0^{fs} = \underline{r}k_0^{fs}$ (i.e. transparent banks that reveal their type) are willing to self-select this supervisory contract. In such a case, the role of the supervisor is minimal. In turn, the self-selection of the supervisory regime by the bank and the less intense role of the supervisor is what allows to avoid the negative welfare effects of the capture of the supervisor by banks. More risky, less capitalized and more opaque banks do not choose the Flexible Supervision contract and are subject to the mandatory, more stringent supervisory regime.

Policy implications of these results are straightforward. Financial stability committees should avoid the welfare costs due to the threat of supervisory capture by enacting a Flexible Supervision regime in addition to the traditional Mandatory regime. Under these two regimes, the less risky banks are willing to signal their type by putting more capital at risk and being more transparent. In exchange, they are subject to a less stringent intervention by the supervisor which, in turn, reduces the scope for supervisory capture with welfare improving effects. This Flexible regime needs to be complemented with a more stringent, Mandatory Supervision regime applied to the rest of the banking system. Of course, the calibration of the thresholds to separate these regimes is an empirical, open question.

4. Extensions

In this section we consider several extensions to the baseline model and discuss their implications for the robustness of the previous section results. Proof and technicalities are in Appendix B. In particular, we show that the advantages of Flexible Supervision hold when we consider (i) more than two levels of banks' riskiness (Section 4.1); (ii) that the banker-supervisor coalition can forge information in addition to conceal it (Section 4.2); (iii) the simultaneous presence of benevolent and self-interested supervisors (Section 4.3); (iv) the presence of supervisors who differ with respect to their ability to collect evidence (Section 4.4); and (v) the possibility of ex ante collusion as long as the supervisor and the banker cannot credible commit to a side-contract (Section 4.5).

4.1. Multiple Levels of Bank's Riskiness

One simplifying assumption that we have maintained throughout the paper is that there are only two levels of bank's riskiness. In this section we discuss the main features of an extension to multiple levels of risks. The baseline model can be easily adapted to consider that there are N possible levels of risk $r \in \{r_1, r_2, ..., r_N\}$, with $r_i < r_j$ for any $i < j$. Denote by α_i the probability that $r = r_i$ with $\alpha_i \in (0,1)$ for all i and $\sum_{i=1}^{N} \alpha_i = 1$. As before, the supervisor observes a signal correlated with the bank's true level of risk. The signal σ can be either informative, i.e. $\sigma = r$, with probability $\varepsilon > 0$, or uninformative, i.e. $\sigma = \emptyset$, with probability $1 - \varepsilon$.

As in the baseline model, supervision mitigates the information gap existing between the FSC and banks. In Appendix B we derive optimal regulation for the multiple levels of riskiness case when the supervisor is benevolent (Lemma 6) and when there is no supervision (Lemma 7). These results are benchmarks for the results in this section.

Under Mandatory Supervision, avoiding the risk of capturing a self-interested supervisor exacerbates the distortion of the level of capital a bank puts at risk whenever the collected evidence is non-informative (the only exception is for the case of the lowest-risk bank as we will see next). Hence, the second-best solution, i.e. the optimal regulation when the supervisor is benevolent, cannot be attained under Mandatory Supervision. In this case, the FSC must promise a positive wage to the supervisor when she reports informative evidence about the bank's riskiness. This salary is optimally set equal to the value to the supervisor of the maximum bribe a banker may be willing to pay to have the informative signal concealed, that is:

$$w_i^i \geq \tau[B_i^{\varnothing} - B_i^i] \tag{CIC_i}$$

where the subscript denotes the level of risk reported by the banker and the superscript denotes the signal reported by the supervisor (henceforth, we follow this convention). The above capture-proof incentive compatibility constraint implies that preventing regulatory capture is costly and magnifies the distortion of the required levels of capital put at risk by the banks. In particular, the FSC maximizes the following objective function

$$\begin{aligned} W =& \varepsilon \sum_{i=1}^{N} \alpha_i \left(\Psi(k_i^i) - \lambda w_i^i - \lambda B_i^i - (1+\lambda) r_i k_i^i \right) \\ &+ (1-\varepsilon) \sum_{i=1}^{N} \alpha_i \left(\Psi(k_i^{\varnothing}) - \lambda w_i^{\varnothing} - \lambda B_i^{\varnothing} - (1+\lambda) r_i k_i^{\varnothing} \right) \end{aligned} \tag{5}$$

subject to (CIC_i), the supervisor's participation constraints and the following constraints. There are $2N$ participation constraints for the banker:

$$B_i^i = \pi_i^i - r_i k_i^i \geq 0 \tag{PC_i^i}$$

and

$$B_i^{\varnothing} = \pi_i^{\varnothing} - r_i k_i^{\varnothing} \geq 0 \tag{$PC_i^{\varnothing}$}$$

As is standard in the contract theory literature (See, for instance, Bolton and Dewatripont, 2005) at the optimum the participation constraint of bank N binds, since the highest-risk banker never finds it profitable to choose the contract designed for a different banker. Since the Spence-Mirrless single-crossing condition is satisfied, monotonicity holds and we can focus on local incentive compatibility constraints, that is it suffices that the FSC makes banker i unwilling to choose the regulatory contract designed for $i+1$, for all $i \in \{1, ..., N-1\}$.[21] The local incentive compatibility constraints for each banker $i = 1, ..., N-1$ may now

[21]Monotonicity refers to the allocation rule, i.e. $k_i > k_j$ if $r_j > r_i$ for $j > i$. That the Spence-Mirrless condition is satisfied can be seen from:

$$\frac{\partial}{\partial r}\left[-\frac{\partial B/\partial k}{\partial B/\partial \pi}\right] > 0$$

Note that in this setting a *higher* type means a lower r. This must be taken into account when verifying that the single-crossing condition is verified.

be written as follows:

$$B_i^{\emptyset} = \pi_i^{\emptyset} - r_i k_i^{\emptyset} \geq \pi_{i+1}^{\emptyset} - r_i k_{i+1}^{\emptyset} = B_{i+1}^{\emptyset} + \underbrace{(r_{i+1} - r_i)}_{\Delta r_{i+1}} k_{i+1}^{\emptyset} \qquad (IC_i^{\emptyset})$$

The following Lemma characterizes the optimal capture-proof contract under Mandatory Supervision.

Lemma 4. *The optimal capture-proof contract under Mandatory Supervision entails the following salaries for the supervisor:* $w_j^{\emptyset} = 0$ *for* $j = 1, ..., N$, *and* $w_i^i = \tau[B_i^{\emptyset} - B_i^i]$ *for* $i = 1, 2, ...N$. *The banker's utility is* $B_i^i = 0$, *for* $i = 1, ..., N$, $B_j^{\emptyset} = B_{j+1}^{\emptyset} + \Delta r_{j+1} k_{j+1}^{\emptyset}$, *for* $j = 1, ...N-1$ *and* $B_N^{\emptyset} = 0$. *The bank's required levels of capital at risk are such that* $\Psi'(k_i^i) = (1+\lambda) r_i$ *for* $i = 1, ..., N$, $\Psi'(k_1^{\emptyset}) = (1+\lambda) r_1$, $\Psi'(k_j^{\emptyset}) = (1+\lambda) r_j + \frac{\sum_{i=1}^{j-1} \alpha_i}{\alpha_j} \frac{1-\varepsilon(1-\tau)}{1-\varepsilon} \lambda \Delta r_j$, *for* $j = 2, ..., N$.

Following the same reasoning as in the rest of the analysis, it is straightforward to see how the benefits of Flexible Supervision hold in this extended setting. Under Mandatory Supervision, banker i, with $i < N$, collects a rent only if $\sigma = \emptyset$, whereas if $\sigma = r_i$ a rent must be paid to the supervisor to avoid capture. Therefore, banker i can be induced to bypass supervision when he is aware that the signal is informative. This can be achieved by simply offering the banker a rent at least equal to zero. The FSC should offer $N-1$ supervisor-free contract $\{k_i^0, \pi_i^0\}$ to the banker, one for each possible level of risk, with the exception of the highest one. If the banker chooses one of the supervisor-free contract, his bank bypasses supervision. This supervisor-free contract is set in such a way that banker i is as well-off choosing it as he would have been had his bank been subjected to direct supervision. As this allows the FSC to overcome regulatory capture without causing any information loss, the level of welfare that can be achieved through Flexible Supervision is the same as when the supervisor is benevolent.

Formally, to induce banker i, with $i = 1, ..., N-1$, to accept the supervisor-free contract when he is aware that the signal is informative, the FSC must impose the following incentive compatibility constraint:

$$B_i^0 = \pi_i^0 - r_i k_i^0 \geq \pi_i^i - r_i k_i^i = B_i^i \qquad (IC_i^0)$$

The FSC must also make sure that other bankers are willing to choose the supervisor-free contract designed for banker i. This is achieved by setting two additional set of incentive constraints. The first one ensures that bankers whose signal is not informative cannot gain from choosing any supervision-free option:

$$\pi_j^{\emptyset} - r_j k_j^{\emptyset} \geq \pi_i^0 - r_j k_i^0 \qquad (IC_{\emptyset,i}^0)$$

for all $i = 1, ..., N-1$ and $j = 1, ..., N$, with $j \neq i$. The second set of incentive constraints that a banker j whose signal is informative cannot gain from choosing the supervisor-free option designed for banker i:

$$\pi_j^j - r_j k_j^j \geq \pi_i^0 - r_j k_i^0 \qquad (IC_{j,i}^0)$$

for all $i = 1, ..., N-1$ and $j \neq i$. The FSC maximizes the following objective function:

$$\begin{aligned} W =& \varepsilon \sum_{i=1}^{N-1} \alpha_i \left(\Psi(k_i^0) - \lambda B_i^0 - (1+\lambda) r_i k_i^0 \right) \\ &+ \varepsilon \alpha_N \left(\Psi(k_N^N) - \lambda w_N^N - \lambda B_N^N - (1+\lambda) r_N k_N^N \right) \\ &+ (1-\varepsilon) \sum_{i=1}^{N} \alpha_i \left(\Psi(k_i^\emptyset) - \lambda w_i^\emptyset - \lambda B_i^\emptyset - (1+\lambda) r_i k_i^\emptyset \right) \end{aligned} \quad (6)$$

subject to (IC_i^0), $(IC_{\emptyset,i}^0)$, $(IC_{j,i}^0)$, (CIC_i), $(IC_i^\emptyset)$, (PC_i^i), $(PC_i^\emptyset)$ and the supervisor's participation constraints. The following Proposition characterizes the optimal capture-proof contract under Flexible Supervision.

Proposition 2. *The optimal capture-proof contract under Flexible Supervision entails the following salaries for the supervisor:* $w_N^N = w_j^\emptyset = 0$ *for* $j = 1, ..., N$. *The banker's utility is* $B_i^0 = 0$ *for* $i = 1, ..., N-1$; $B_j^\emptyset = B_{j+1}^\emptyset + \Delta r_{j+1} k_{j+1}^\emptyset$, *for* $j = 1, ...N-1$; *and* $B_N^\emptyset = B_N^N = 0$. *The bank's required levels of capital at risk are such that* $\Psi'(k_i^0) = (1+\lambda) r_i$ *for* $i = 1, ..., N-1$, $\Psi'(k_1^\emptyset) = (1+\lambda) r_1$, $\Psi'(k_j^\emptyset) = (1+\lambda) r_j + \frac{\sum_{i=1}^{j-1} \alpha_i}{\alpha_j} \lambda \Delta r_j$, *for* $j = 2, ..., N$, $\Psi'(k_N^N) = (1+\lambda) r_N$.
Off-the-equilibrium path, $w_i^i = \tau [B_i^\emptyset - B_i^i]$ *for* $i = 1, ..., N-1$; $B_i^i = 0$, *for* $i = 1, ..., N-1$; $\Psi'(k_i^i) = (1+\lambda) r_i$ *for* $i = 1, ..., N-1$.

Hence, in this more general setting regulatory capture can be costlessly prevented through Flexible Supervision. A banker can be presented with the possibility of bypassing direct supervision by accepting a specific regulatory profile which is design for his bank's level of risk. These regulatory profiles are designed in such a way that the interaction between the banker and the supervisor is averted in those cases where otherwise the incentives for capture are the strongest. As a result, social welfare is the same as when regulatory capture is not a concern because the supervisor either cannot or does not want to conceal evidence.

From a qualitative standpoint, there are few differences with the baseline model. The bank which has the highest level of risk, i.e. $r = r_N$, is always scrutinized by a supervisor. Conversely, the other banks may or may not be subjected to a supervisory assessment. The regulatory profiles are such that a banker who knows that the supervisor would collect informative evidence about the true level of risk of his bank decides to bypass direct supervision by self-selecting the regulatory profile that has been designed for his bank. Flexible Supervision enables the FSC to alleviate the capital distortion as compared to a setting in which supervision is solely mandatory. Moreover, the second-best optimal regulation may be implemented. Although some banks choose not to be subjected to a supervisory assessment, there is not loss of information because the banker's decision not to be scrutinized by the supervisor reveals information about his bank's riskiness.

4.2. Soft Information

Thus far we have considered that the supervisor-banker coalition is only able to conceal evidence to the FSC because supervisory information was assumed to be hard. However, the riskiness of a bank may be non-verifiable by third parties because it may be based on soft information obtained during the asset quality assessment process by the supervisor. In this case supervisory information is soft and the banker and the supervisor may also be able to engage in manipulation of the bank's documentation so as to produce bogus evidence. In this section, we study whether the benefits of Flexible Supervision carry over to a setting in which the supervisor-banker coalition can forge evidence, namely when information is *soft* for the coalition.

To study this situation we extend the baseline model by assuming that the supervisor can send a message $m_s \in \{\bar{r}, \underline{r}, \emptyset\}$ irrespective of the signal collected as long as the banker cooperates. It follows that forging evidence must be in the interest of both members of the coalition.[22] Conversely, if the banker does not cooperate, the supervisor can send a message $m_s \in \{r, \emptyset\}$ if $\sigma = r$ and $m_s = \emptyset$ if $\sigma = \emptyset$. This is consistent with the idea that the banker's cooperation is critical for the supervisor to manipulate evidence.

In practice, these assumptions give rise to additional capture opportunities. More precisely, the coalition has now a clear incentive to forge evidence and report that the bank is high-risk when the risk is actually low. By doing so, the banker would earn a rent that he could split with the supervisor. To prevent this type of capture, FSC must impose the following capture-incentive-compatibility constraints:

$$(w_2 - w_4) \geq \tau(B_4 - B_2 + \Delta r k_4) \qquad (CIC24)$$

$$(w_1 - w_4) \geq \tau(B_4 - B_1 + \Delta r k_4) \qquad (CIC14)$$

It is important to note that when (CIC) and $(CIC24)$ are satisfied, $(CIC14)$ automatically holds.[23]

We first characterize the optimal capture-proof contract when the FSC wants to implement Mandatory Supervision. We then show the welfare gains that can be achieved when the FSC adopts Flexible Supervision.

The following Lemma characterizes the optimal capture-proof contract under Mandatory Supervision.

Lemma 5. *The optimal capture-proof contract when information is soft and supervision is mandatory (mss) entails:*
If $\tau < \frac{\varepsilon}{1+\varepsilon}$*:*

(i) *the following salaries for the supervisor* $w_i^{mss} = 0$ *for* $i = 3, 4$, $w_1^{mss} = \tau \Delta r k_4^{mss}$, *and* $w_2^{mss} = \tau \Delta r (k_4^{mss} - k_3^{mss})$;

(ii) *the following profits for the bank:* $\pi_1^{mss} = \underline{r} k_1^{mss}$, $\pi_2^{mss} = \underline{r} k_2^{mss} + \Delta r k_3^{mss}$, *and* $\pi_j^{mss} = \bar{r} k_j^{mss}$ *for* $j = 3, 4$;

(iii) *the following required bank's levels of capital at risk:* $\Psi'(k_i^{mss}) = (1+\lambda)\underline{r}$ *for* $i = 1, 2$, $\Psi'(k_3^{mss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}(1-\tau)\lambda \Delta r$, *and* $\Psi'(k_4^{mss}) = (1+\lambda)\bar{r} + \frac{\alpha}{(1-\alpha)\varepsilon}\tau\lambda\Delta r$.

If $\tau \geq \frac{\varepsilon}{1+\varepsilon}$*:*

(i) *the following salaries for the supervisor* $w_i^{mss} = 0$ *for* $i = 2, 3, 4$, $w_1^{mss} = \tau \Delta r k_j^{mss}$ *for* $j = 3, 4$;

(ii) *the following profits for the bank:* $\pi_1^{mss} = \underline{r} k_1^{mss}$, $\pi_2^{mss} = \underline{r} k_2^{mss} + \Delta r k_j^{mss}$ *for* $j = 3, 4$, *and* $\pi_j^{mss} = \bar{r} k_j^{mss}$ *for* $j = 3, 4$;

[22] To put it differently, the banker has a veto power which limits the falsification ability of the supervisor.

[23] We show this in Appendix B.

(iii) *the following required bank's levels of capital at risk:* $\Psi'(k_i^{mss}) = (1+\lambda)\underline{r}$ *for* $i = 1,2$, $\Psi'(k_j^{mss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}[\varepsilon\tau + (1-\varepsilon)]\lambda\Delta r$ *for* $j = 3,4$.

There are two alternative ways that the FSC can pursue to discourage all the capture opportunities. Their optimality critically depends on the weakness of the institutional setting, τ. In either case, as compared to the hard-information scenario, the presence of soft information gives rise to a distortion from the efficient level of the capital put at risk by the banker in state 4.

When $\tau < \varepsilon/(1+\varepsilon)$, the institutions are relatively strong and the FSC prefers to deter capture in state 2 by rewarding the supervisor $w_2^{mss} = \tau\Delta r(k_4^{mss} - k_3^{mss})$. This increases the payment the supervisor receives in state 1, making it more costly to prevent the coalition from concealing evidence of low-risk. Note that in this region of the parameter values the FSC distorts the capital put at risk in state 4 less than in state 3.

When $\tau \geq \varepsilon/(1+\varepsilon)$, the institutions are relatively weak and the rewards that should be paid to the supervisor to deter capture according to the previous mechanism would be inefficiently high. Therefore the FSC prefers to distort capital in state 4 as much as in state 3, i.e., $k_3^{mss} = k_4^{mss}$. By doing so, a low-risk banker is indifferent between state 4 and state 3 and he will never try to capture the supervisor to forge evidence of high riskiness as long as $(IC23)$ holds. As a result, the supervisor collects no rent in state 2 ($w_2^{mss} = 0$).

We show in the Appendix B that welfare strictly decreases in the weakness of the institutional setting.

Irrespective of the strength of the institutional setting, we now show that Flexible Supervision improves social welfare. The intuition is that Flexible Supervision can be tailored in such a way that the banker decides not to be subjected to supervision in state 1, that is when the supervisor would collect a rent while the banker would not.[24] This would allow the FSC to pay the supervisor's reward only off-the-equilibrium path and mitigate the distortion of capital when the bank is high-risk. However, when information is soft, flexible supervision does not fully eliminate the inefficiencies brought about by the threat of capture.

The FSC maximizes (3) subject to (PCi), (IC23), (IC01), (IC20), (IC30), (IC40), (CIC), (CIC24), with $i \in \{0,1,2,3,4\}$. Proposition 3 characterizes the optimal contract when supervision is flexible and information is soft.

Proposition 3. *The optimal capture-proof contract when information is soft and supervision is flexible (fss) entails:* *If* $\tau < \varepsilon$*:*

(i) *the following salaries for the supervisor* $w_i^{fss} = 0$ *for* $i = 3,4$, *and* $w_2^{fss} = \tau\Delta r(k_4^{fss} - k_3^{fss})$;

(ii) *the following profits for the bank:* $\pi_0^{fss} = \underline{r}k_0^{fss}$, $\pi_2^{fss} = \underline{r}k_2^{fss} + \Delta r k_3^{fss}$, *and* $\pi_j^{fss} = \bar{r}k_j^{fss}$ *for* $j = 3,4$;

(iii) *the following required bank's levels of capital at risk:* $\Psi'(k_i^{fss}) = (1+\lambda)\underline{r}$ *for* $i = 0,2$, $\Psi'(k_3^{fss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}(1-\tau)\lambda\Delta r$, *and* $\Psi'(k_4^{fss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}\frac{(1-\varepsilon)}{\varepsilon}\tau\lambda\Delta r$;

[24] In principle, the FSC could also induce the low-risk banker to bypass supervision also in state 2. However this would be inefficient as the FSC should make the low-risk banker willing to accept this option irrespective of the supervisor's signal, thereby relinquishing the supervision altogether.

(iv) *off-the-equilibrium path,* $w_1^{fss} = \tau \Delta r k_4^{fss}$*,* $\pi_1^{fss} = \underline{r} k_1^{fss}$*, and* $k_1^{fss} = k_0^{fss}$*.*

If $\tau \geq \varepsilon$*:*

(i) *the following salaries for the supervisor* $w_i^{fss} = 0$ *for* $i = 2, 3, 4$*;*

(ii) *the following profits for the bank:* $\pi_0^{fss} = \underline{r} k_0^{fss}$*,* $\pi_2^{fss} = \underline{r} k_2^{fss} + \Delta r k_3^{fss}$*, and* $\pi_j^{fss} = \bar{r} k_j^{fss}$ *for* $j = 3, 4$*;*

(iii) *the following required bank's levels of capital at risk:* $\Psi'(k_i^{fss}) = (1+\lambda)\underline{r}$ *for* $i = 0, 2$*,* $\Psi'(k_j^{fss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}[1-\varepsilon]\lambda \Delta r$ *for* $j = 3, 4$*;*

(iv) *off-the-equilibrium path,* $w_1^{fss} = \tau \Delta r k_j^{fss}$*,* $\pi_1^{fss} = \underline{r} k_1^{fss}$*, and* $k_1^{fss} = k_0^{fss}$*.*

Again, the FSC can undertake two alternative methods to discourage all the capture opportunities, whose optimality is a function of τ.

When $\tau < \varepsilon$, the FSC prefers to deter capture in state 2 by rewarding the supervisor $w_2^{fss} = \tau \Delta r (k_4^{fss} - k_3^{fss})$, which is paid on-the-equilibrium path. While this increases the payment the supervisor receives in state 1, w_1^{fss} is paid only off the equilibrium path. Being aware that the supervisor would not accept to be captured, the low-risk banker will bypass supervision when the signal is informative. Thanks to Flexible Supervision, the distortion of capital in state 4 is mitigated with respect to Mandatory Supervision.

When $\tau \geq \varepsilon$, the rewards that should be paid to the supervisor on-the-equilibrium path to deter capture would be too high. Therefore the FSC prefers to distort capital in state 4 as much as in state 3, i.e., $k_3^{fss} = k_4^{fss}$.

It is immediate to see that Flexible Supervision entails lower distortions in the levels of capital put at risk than Mandatory Supervision. This is so irrespective of the strength of the institutional setting. Moreover, in Appendix B we show that welfare strictly decreases in the weakness of institutions only under the Mandatory Supervision regime. This is not the case under Flexible Supervision, as for $\tau \geq \varepsilon$, the quality of the institutional setting only affects the payment the supervisor receives off-the-equilibrium path.

Finally, the presence of soft-information bites as it prevents the FSC to achieve the benevolent supervisor's level of welfare, as highlighted by the following corollary:

Corollary 2. *Under soft information, Optimal Flexible Supervision strictly dominates Optimal Mandatory Supervision but does not achieve the second-best outcome, i.e.:* $W^{bs} > W^{fss} > W^{mss}$*.*

4.3. Benevolent and Self-interested Supervisors

We have considered two polar cases in the baseline model. One in which the supervisor is benevolent and another in which the supervisor is self-interested. In the latter case, we have shown how social welfare can be improved through the Flexible Supervision mechanism. Arguably in the real world both types of supervisor may coexist and, as a result, it is important to determine whether our conclusion on the optimality of Flexible Supervision would persist when we allow for the presence of a fraction of supervisors who are benevolent.

To this end, suppose that the supervisor is benevolent with probability $\beta \in (0, 1)$ and self-interested with probability $(1 - \beta)$. Her true type is her private information while both the banker and the FSC only know the probability distribution of the supervisor's type. Note first that the FSC is unable to hire only benevolent supervisors and implement the second-best solution under Mandatory Supervision. Self-interested supervisors would pretend to be benevolent as they expect to pocket a side transfer from the banker in state 1.[25]

If the FSC wants to implement the mandatory supervisory option it has two alternatives. First, it can prevent collusion by setting a reward to a supervisor who reports that the bank has a low-risk.[26] Alternatively, the FSC can pay the supervisor a flat salary thereby inducing only a benevolent supervisor to report truthfully. A self-interested supervisor would collude with the banker in state 1.[27] Regardless of the FSC's favorite solution when supervision is mandatory, Flexible Supervision unambiguously increases welfare as it eliminates any additional distortion engendered by the presence of some self-interested supervisors or by the non perfect detectability of capture as in the baseline model.

4.4. Differently-Skilled Supervisors

Supervisors may differ in dimensions other than their innate preference for a benevolent behavior. In this section we explore the possibility that the supervisors may differ with respect to their ability to learn the bank's level of risk.[28] Specifically, we consider the polar case in which there are two types of supervisors: a highly-skilled one who observes the bank's riskiness with probability one, a low-skilled one who never observes the riskiness of the bank. It is common knowledge that there is a proportion $\varepsilon \in (0, 1)$ of high-skilled supervisors. At stage 1 the banker does not know which supervisor will be tasked with collecting information on the bank's riskiness. The FSC is also unable to distinguish between different supervisors.

Below we provide an intuition as to how Flexible Supervision should be tailored to deal with the presence of differently-skilled supervisors. In Appendix B we show that this setting is analogous to one in which there is only one type of supervisor who observes with probability ε the true level of a bank's riskiness (like in the basic model) as long as the banker and the FSC are initially unaware of the supervisor's signal.

[25]In fact, as argued in a different context by Mishra and Mookherjee (2012), absent wealth-constraints of supervisors, the FSC might benefit from auctioning off the right to supervise banks, in so selecting only self-interested supervisors. Unlike benevolent supervisors, corruptible ones would be willing to pay up to the expected value of the rents they expect to collect to be hired.

[26]Note that this generates an unnecessary rent to a benevolent supervisor who would have unconditionally reported truthfully the bank's riskiness.

[27]Tolerating collusion implies that the low-risk bank achieves $\pi_2 > \pi_1$ also in state 1 with probability $(1 - \beta)$. This increases the downward distortion of capital in state 3. The relative efficiency of tolerating collusion increases in the probability that the supervisor is benevolent and in the strength of the institutional setting, namely in $1 - \tau$. Indeed, in an environment in which banking supervision is mandatory, the absence of rewards contingent on the content of the reports for the supervisors can be explained by the presence of strong institutions and high-moral standards of the civil servants tasked with supervising banking institutions. In a related vein, Giebe and Gurtler (2012) show that the leniency bias often observed in organizations (i.e. the practice of overstating employees' performance) can be explained by incomplete information about the supervisors' social preferences.

[28]In a related vein, Boot and Thakor (1993) develop a model in which there is uncertainty as to the supervisor's ability to monitor the bank's asset choice.

First, note that the optimal contract under Mandatory Supervision is unaltered, namely it is the same as that characterized in Lemma 3. The banker enjoys a rent when his bank is low-risk and it turns out that the supervisor is low-skilled. This is due to his ability to mimic a high-risk bank in state 3. The value of this rent is $\Delta r k_3$. To induce the high-skilled supervisor to report that the bank is low-risk, the FSC must set a wage $w_1 = \tau \Delta r k_3$.

When we allow for Flexible Supervision, the optimal contract differs from that characterized in Proposition 1, but it shares the same desirable feature of achieving the second-best outcome. In particular, Flexible Supervision induces the banker to opt for the supervision-free contract when the bank is low-risk if:

$$\pi_0 - \underline{r}k_0 \geq \varepsilon(\pi_1 - \underline{r}k_1) + (1-\varepsilon)(\pi_2 - \underline{r}k_2)$$

Conversely, the banker decides to be inspected when the bank's risk is high if:

$$\varepsilon(\pi_4 - \bar{r}k_4) + (1-\varepsilon)(\pi_3 - \bar{r}k_3) \geq \pi_0 - \bar{r}k_0$$

Intuitively, when there are differently-skilled supervisor, it is optimal for the FSC to offer a contract that induces the bankers to opt to bypass supervision whenever their banks are low-risk. The FSC can persuade the low-risk bankers to do so by offering the expected value of the information rent that they would obtain given that a supervisor would learn their true level of risk with probability ε. This information rent is equal to $(1-\varepsilon)\Delta r k_3$. In expectation the low-risk bankers are at least as well-off by choosing the supervision-free contract as they would be under supervision.

Interestingly, when there are differently-skilled supervisors, low-risk bankers would always choose to bypass supervision whereas only high-risk bankers would always be supervised. Moreover, the low-risk bankers would always derive positive utility in expected term, while the participation constraints of the high-risk ones would always bind in expectation. This marks a significant departure from the sorting of high and low-risk banks described in Section 3,[29] and highlights how implementing Flexible Supervision would require a clear understanding of the actual characteristics of the pool of potential supervisors.

4.5. No-collusion in the Participation Decisions

In the baseline model, we have assumed that the banker's and supervisor's decisions as to whether or not to participate are made non-cooperatively at the beginning of the game.[30] As a consequence, the supervisor and the banker can only collude at stage 3 after they have both accepted the contract offered by the FSC. This assumption is sometimes referred to as *no-collusion in participation decisions* in the literature on collusion in hierarchies, and it is crucial for the effectiveness of Flexible Supervision.[31] In order to clarify its

[29]Where low-risk bankers prefer to be supervised only when they know that the supervisor is not aware of their riskiness.

[30]This assumption can also be found in a number of other papers in the literature on collusion in hierarchies (see Faure-Grimaud et al., 2003; Celik, 2009; Motta, 2012, and Burlando and Motta 2015). Some authors, such as Mookherjee and Tsumagari (2004), have departed from this assumption, analyzing a framework wherein the agents communicate before deciding whether or not to participate in the mechanism.

[31]See Motta 2012.

role, we need to distinguish between two alternative cases. First, if the supervisor has the ability to credibly commit to a side-contract at the beginning of the game, then our mechanism cannot be implemented. The supervisor could promise the banker a positive rent in state 1 and, as a result, the banker would not choose the Flexible Supervision contract. Second, suppose instead that the supervisor lacks such commitment ability. Then, even if she agreed with the banker on reporting $m_s = \emptyset$ in state 1 in exchange for a side transfer, ex-post she would rather report truthfully $m_s = \underline{r}$ so as to collect a salary from the FSC, which is at least as large as the maximum side transfer the banker would be willing to pay. Anticipating that the supervisor's promise is time-inconsistent and fearing to be held-up, the banker of the low-risk bank would continue to choose a Flexible Supervision contract in state 1.

The implementation of Flexible Supervision crucially depends on the fact that the supervisor and the supervisee must not be able to credible collude ex-ante, namely before the supervisory information is collected. Since the repeated interaction of supervisors with their supervisees might make it more likely ex-ante collusion, then a potential remedy to this problem is to continuously reassign supervisors and retain a record of which supervisor is sent to inspect each bank. This is a standard prescription to make capture more difficult, which would continue to hold also if Flexible Supervision were implemented.

5. Concluding Remarks

In this paper we analyze the welfare implications of introducing Flexible Supervision in addition to the traditional Mandatory Supervision contracts. We have shown that a mechanism which allows to avoid the interaction between bankers and supervisors in those states in which the bankers would be willing to capture the supervisors (i.e., Flexible Supervision) allows to overcome the threat of capture. In spite of the lack of interaction between supervisors and supervisees, the FSC is still able to obtain valuable information about the banks's riskiness. This is so as the decision of bypassing supervision reveals information about the bank's riskiness. As a result, Flexible Supervision accomplishes the main aim of supervision, namely that of bridging the information gap between the regulator and the bank, and allows to attain the second-best solution under asymmetric information and the threat of capture of the supervisor by the banks.

The results have important implications for the design of supervisory arrangements. A close supervision of banking institution is deemed necessary to foster financial stability, but the costs it imposes on financial institutions are increasingly criticized. Flexible Supervision would enable the regulator to obtain the same quality of information about the banks' risk, while reducing significantly welfare costs. Under Flexible Supervision, the less risky banks are willing to signal their type by putting more capital at risk and being more transparent. In exchange, they are subject to a less stringent intervention by the supervisor which, in turn, reduces the scope for supervisory capture with welfare improving effects. This Flexible regime needs to be complemented with a more stringent, mandatory supervision regimen applied to the rest of the banking system. Mandatory and Flexible Supervision may be interpreted as particular strategies in banking supervision. In practice, bank supervisors generally apply different supervisory strategies to banks according to their riskiness and other soundness indicators. Hence, the results in this paper provide a rationale for these kind of supervisory strategies.

The welfare gains stemming from the implementation of Flexible Banking Supervision depend on the strength of the institutions and of the banking lobby. When institutions are weak, corruption is more pervasive and recent evidence (see Chen et al., 2015) points to a negative relationship between banks' stability and perception of corruption in a country, which makes the benefits of Flexible Supervision all the more substantial.[32] However, the gains may be large even in those countries in which the institutional setting is strong but the banking lobby is extremely powerful and phenomena such as revolving doors allow banks to capture supervisors. Furthermore, even in those countries in which regulatory capture is a minor concern, Flexible Supervision may streamline regulation saving on compliance costs, thereby reducing the bureaucratic burden.

The results are robust to a series of extensions to the basic model. More precisely, Flexible Supervision allows the implementation of the second-best optimal regulation, outperforming Mandatory Supervision, when we consider more than two levels of bank riskiness (as we do in the baseline model). This result also holds when the financial stability committee does not know the type of the supervisor, who can be either benevolent or self-interested and even can differ in the ability to learn the bank's level of risk. If supervisory information is soft, instead of hard information as it is assumed in the baseline model, then the supervisor-banker coalition can forge (and not only conceal) evidence to the financial stability committee. In this case, preventing all possible forms of capture is strictly more costly under Mandatory than under Flexible Supervision, i.e. the latter still outperforms the former in terms of social welfare. However, it is not longer possible to implement the second-best optimal regulation. A potential caveat to implement Flexible Supervision is that the banker must not be able to capture the supervisor ex-ante, namely before the latter collects the supervisory signal. A potential remedy to this problem is to continuously reassign supervisors to banks, a standard practice which should continue if Flexible Supervision were implemented.

Appendix A

Proof of Lemma 1

In state $i \in \{1, 4\}$, the FSC maximizes

$$\max_{k_i, \pi_i} W = \Psi(k_i) - \lambda(\pi_i - r_i k_i) - (1 + \lambda) r_i k_i$$

subject to:

$$\pi_i - r_i k_i \geq 0 \tag{PCi}$$

[32] More specifically, Chen et al. (2015) find that banks engage in more risky activities in those countries in which the severity of corruption is higher. This finding is robust to different measures of a bank's risk, which are standard in the literature, like z-scores and ratio of non-performing loans.

with $r_1 = \underline{r}$ and $r_4 = \bar{r}$.
At the optimum, (BPCi) is binding: Otherwise the FSC would find it profitable to reduce the rent allocated to the bank. Hence, $\pi_i = r_i k_i$. Replacing (BPCi) into the objective function we obtain a problem in k_i only:

$$\max_{k_i} W = \Psi(k_i) - (1+\lambda) r_i k_i.$$

Taking partial derivative with respect to k_i and equalizing it to zero leads to:

$$\Psi'(k_i) = (1+\lambda) r_i$$

If the signal is uninformative, the FSC does not distinguish between state 2 from state 3 and vice versa. Hence, the FSC imposes the following two incentive compatibility constraints in order to prevent a bank with a given riskiness to choose a contract designed for a bank with a different level of risk:

$$B_2 = \pi_2 - \underline{r}k_2 \geq \pi_3 - \underline{r}k_3 = B_{23} \tag{IC23}$$

$$B_3 = \pi_3 - \bar{r}k_3 \geq \pi_2 - \bar{r}k_2 = B_{32} \tag{IC32}$$

In states i, with $i \in \{2, 3\}$, the FSC maximizes

$$\begin{aligned} \max_{k_2,k_3,\pi_2,\pi_3} W =& \alpha[\Psi(k_2) - \lambda[\pi_2 - \underline{r}k_2] - (1+\lambda)\underline{r}k_2] \\ &+ (1-\alpha)[\Psi(k_3) - \lambda[\pi_3 - \bar{r}k_3] - (1+\lambda)\bar{r}k_3] \end{aligned}$$

subject to (IC23), (IC32) and

$$\pi_2 - \underline{r}k_2 \geq 0 \tag{PC2}$$

$$\pi_3 - \bar{r}k_3 \geq 0 \tag{PC3}$$

Using standard arguments we know that only (IC23) and (PC3) bind at the optimum. Hence, we can rewrite the objective function of the FSC as follows:

$$\begin{aligned} \max_{k_2,k_3} W =& \alpha[\Psi(k_2) - \lambda[\Delta r k_3] - (1+\lambda)\underline{r}k_2] \\ &+ (1-\alpha)[\Psi(k_3) - (1+\lambda)\bar{r}k_3] \end{aligned}$$

taking partial derivatives with respect to k_2 and k_3 and setting them equal to zero we find:

$$\begin{aligned} \Psi'(k_2) &= [(1+\lambda)\underline{r}] \\ \Psi'(k_3) &= [(1+\lambda)\bar{r} + \underbrace{\lambda\Delta r}_{\text{distortion to 3's capital}}] \end{aligned}$$

From (IC23) and (PC3) it is immediate to retrieve the result stated in the text.

□

Proof of Lemma 2

When the FSC maximizes (2) subject to $(\overline{PC})$ and $(\underline{IC})$, it can set the level of capital and the profit of the bank for all risk announcements.

Note that the optimal profit levels can be obtained from the two constraints which are binding at the optimum. If they were not, the FSC could reduce the profits so as to make the constraints bind. From $(\overline{PC})$:

$$\bar{\pi} = \bar{r}\bar{k}$$

and plugging this value into the $(\underline{IC})$:

$$\underline{\pi} = \underline{r}\underline{k} + \underbrace{\bar{r}\bar{k} - \underline{r}\bar{k}}_{\Delta r\bar{k}}$$

Then, substituting these two values into (2), the principal's program becomes:

$$\begin{aligned}\max_{\underline{k},\bar{k}} W =& \alpha[\Psi(\underline{k}) - \lambda\Delta r\bar{k} - (1+\lambda)\underline{r}\underline{k}] \\ &+ (1-\alpha)[\Psi(\bar{k}) - (1+\lambda)\bar{r}\bar{k}]\end{aligned}$$

The first order condition with respect to the level of capital at risk required for the low-risk bank yields:

$$\Psi'(\underline{k}) = (1+\lambda)\underline{r}$$

which is the same level that would have been required in a perfect-information environment, that is, the capital at risk of the low-risk bank is not distorted. In contrast, the first order condition with respect to the level of capital at risk required for the high-risk bank yields:

$$(1-\alpha)(\Psi'(\bar{k}) - (1+\lambda)\bar{r}) = \alpha\lambda\Delta r$$

which can be straightforwardly rearranged as shown in the Lemma. Thus, the high-risk bank is required to be smaller than in the first best as $\Psi(\cdot)$ is an increasing and concave function.

□

Proof of Lemma 3

The proof follows the same reasoning as in Lemma 2. The presence of the additional constraint, (CIC), negatively impacts on social welfare. That constraint binds at the optimum and therefore $w_1 = w_2 + \tau[B_2 - B_1]$. The FSC need not pay the supervisor a rent in states 2, 3, and 4 and the banker need not receive a positive surplus in state 1. In contrast the banker expects to receive a surplus equal to Δrk_3 in state 2. Hence, $w_1 = \tau\Delta rk_3$. The FSC's problem can be written as a function of k_i, $i \in \{1,2,3,4\}$ only:

$$\begin{aligned}\max_{k_i, i\in\{1,2,3,4\}} W =& \alpha\varepsilon[\Psi(k_1) - (1+\lambda)\underline{r}k_1 - \lambda(\tau\Delta rk_3)] + \alpha(1-\varepsilon)[\Psi(k_2) - \lambda(\Delta rk_3) - (1+\lambda)\underline{r}k_2] \\ &+ (1-\alpha)(1-\varepsilon)[\Psi(k_3) - (1+\lambda)\bar{r}k_3] + (1-\alpha)\varepsilon[\Psi(k_4) - (1+\lambda)\bar{r}k_4]\end{aligned}$$

from which we can derive the following first-order conditions:

$$\frac{\partial W}{\partial k_1} = 0 \Leftrightarrow \Psi'(k_1^{ms}) = (1+\lambda)\underline{r}$$
$$\frac{\partial W}{\partial k_2} = 0 \Leftrightarrow \Psi'(k_2^{ms}) = (1+\lambda)\underline{r}$$
$$\frac{\partial W}{\partial k_3} = 0 \Leftrightarrow \Psi'(k_3^{ms}) = (1+\lambda)\bar{r} + \frac{\alpha(1-\varepsilon(1-\tau))\lambda\Delta r}{(1-\alpha)(1-\varepsilon)}$$
$$\frac{\partial W}{\partial k_4} = 0 \Leftrightarrow \Psi'(k_4^{ms}) = (1+\lambda)\bar{r}$$

The distortion of the bank's required level of capital in state 3 reflects the trade-off existing between efficiency and the rent the FSC gives up to the banker in state 2 and to the supervisor in state 1. In contrast, the FSC can impose the first-best level of capital in the other states of the world.
efficiency and the rent the FSC gives up to the banker in state 2 and to the supervisor in state 1. In contrast, the FSC can impose the first-best level of capital in the other states of the world.
It remains to show that when supervision is mandatory, there is no loss of generality in assuming that (a) the supervisor reports σ truthfully; (b) π, k, and w are conditional on m_b, m_s only; (c) there is no-side transfer in equilibrium, i.e. $b_i = 0$ for all i. Following Laffont and Tirole (1991) we first derive an upper bound to the expected welfare by determining those necessary conditions which must be satisfied by the final allocation in equilibrium. We then show that the solution presented in this Lemma allows to reach such upper bound.
When allowing for side-transfers, the utility functions of the bank and the supervisor can be written as follows:

$$\hat{B}_i = \pi - r_i k_i - b_i$$
$$\hat{S}_i = w_i + \tau b_i$$

Note that for all i it must be that:

$$\hat{B}_i \geq 0 \tag{A1}$$
$$\hat{S}_i \geq 0 \tag{A2}$$

If either of these inequalities is violated, one of the parties refuses to participate - recall that supervision is mandatory. Next consider that

$$\hat{B}_2 \geq \hat{B}_3 + \Delta r k_3 \tag{A3}$$

This is because in state 2 the bank is the only one to know that $r = \underline{r}$ and it can choose the contract designed for type $\bar{r}$ in state 3 getting its payoff, $\hat{B}_3$ as well as a rent $\Delta r k_3$. Finally,

$$\hat{S}_1 - \hat{S}_2 \geq \tau(\hat{B}_2 - \hat{B}_1) \tag{A4}$$

In state 1 the bank and the supervisor can always agree on a side-contract to report that the state is 2. This implies the above condition on the equilibrium allocations.[33]

The expected social welfare can be written as:

$$W = \sum_{i=1}^{4} p_i(\Psi(k_i) + \hat{B}_i + \hat{S}_i - (1+\lambda)(w_i + \pi_i)) \tag{A5}$$

That is,

$$W = \sum_{i=1}^{4} p_i(\Psi(k_i) + (\pi_i - r_i k_i - b_i) + (w_i + \tau b_i) - (1+\lambda)(w_i + \pi_i))$$

$$W = \sum_{i=1}^{4} p_i(\Psi(k_i) - r_i k_i - (1-\tau) b_i - \lambda(w_i + \pi_i))$$

$$W = \sum_{i=1}^{4} p_i(\Psi(k_i) - \lambda w_i - \lambda(\pi_i - r_i k_i) - (1-\tau) b_i - (1+\lambda) r_i k_i)$$

$$W = \sum_{i=1}^{4} p_i(\Psi(k_i) - \lambda(w_i + \tau b_i) - \lambda(\pi_i - r_i k_i - bi) - (1+\lambda)(r_i k_i + (1-\tau) b_i))$$

that leads to:

$$W = \sum_{i=1}^{4} p_i(\Psi(k_i) - \lambda \hat{S}_i - \lambda \hat{B}_i - (1+\lambda)(r_i k_i + (1-\tau) b_i)) \tag{A6}$$

To find an upper bound to EW, we only impose constraints (A1)-(A4) while we ignore other potential constraints.

Since it is costly to give up rents to the supervisor and the bank, the upper bound must satisfy $\hat{S}_i = 0$ for $i = 2, 3, 4$ and $\hat{B}_3 = \hat{B}_4 = 0$. Also having side-transfers is costly and as a result $b_i = 0$ for all i. From condition (A3), it follows that $\hat{B}_2 = \Delta r k_3$ and $\hat{B}_1 = 0$ can be obtained from replacing the condition $\hat{S}_1 = \tau(\hat{B}_2 - \hat{B}_1)$ in the expression of the expected social welfare and maximizing it with respect to $\hat{B}_1$ under the constraint $\hat{B}_1 \geq 0$. Hence, $\hat{S}_1 = w_1 = \tau \hat{B}_2 = \tau \Delta r k_3$.

It is immediate to see that the collusion-proof solution where the contracts are based on m_s and m_b only reaches the upper bound of the expected social welfare.

□

Proof of Proposition 1

We follow the same strategy proof as in the above lemmas. We first determine which constraints bind at the equilibrium. At the optimum, the banker's participation constraints in states $1, 3, 4$ and when he chooses the supervision-free option 0 must bind. Formally we have

$$\pi_i = k_i r_i$$

[33] The parties can transfer utility from the bank to the supervisor at a cost (the depreciation τ.)

for $i \in \{0,1,3,4\}$. The profit in state 2 must satisfy (IC23), hence:

$$\pi_2 = \underline{r}k_2 + \Delta r k_3$$

The transfers paid to the supervisor can all be set equal to zero, with the exception of w_1, which is paid off the equilibrium and must be equal to the value of the maximum bribe the banker would be willing to pay in state 1 if he decides to be subjected to supervision, that is:

$$w_i = 0 \;\text{ for i = 2, 3, 4;} \quad w_1 = \tau \Delta r k_3$$

Replacing all these equations in the FSC's problem (4) leads to:

$$\begin{aligned}\max_{k_i, i\in\{0,2,3,4\}} W =& \alpha\varepsilon[\Psi(k_0) - (1+\lambda)\underline{r}k_0] + \alpha(1-\varepsilon)[\Psi(k_2) - \lambda(\Delta r k_3) - (1+\lambda)\underline{r}k_2] \\ &+ (1-\alpha)(1-\varepsilon)[\Psi(k_3) - (1+\lambda)\bar{r}k_3] + (1-\alpha)\varepsilon[\Psi(k_4) - (1+\lambda)\bar{r}k_4]\end{aligned}$$

Maximization with respect to k_i, for $i = 0,2,3,4$ yields the following first-order conditions:

$$\begin{aligned}\frac{\partial W}{\partial k_0} &= 0 \Leftrightarrow \Psi'(k_0^{fs}) = (1+\lambda)\underline{r} \\ \frac{\partial W}{\partial k_2} &= 0 \Leftrightarrow \Psi'(k_2^{fs}) = (1+\lambda)\underline{r} \\ \frac{\partial W}{\partial k_3} &= 0 \Leftrightarrow \Psi'(k_3^{fs}) = (1+\lambda)\bar{r} + \frac{\alpha\lambda\Delta r}{(1-\alpha)} \\ \frac{\partial W}{\partial k_4} &= 0 \Leftrightarrow \Psi'(k_4^{fs}) = (1+\lambda)\bar{r}\end{aligned}$$

Without loss of generality we can set $\pi_1^{fs} = \underline{r}k_1^{fs}$ with k_1^{fs} satisfying the equation $\Psi'(k_1^{fs}) = (1+\lambda)\underline{r}$.
The banker of a high-risk bank never chooses the non-supervision option whereas the banker of a low-risk bank prefers to be supervised when he knows that the supervisor collects uninformative evidence so as to earn a positive rent.
It is straightforward to see that the distortion in the level of capital put at risk by a bank in state 3 and the rent collected by the bank in state 2 are equivalent to those of second-best as remarked in Corollary 1. Then, the FSC is able to achieve the same expected welfare as in the benevolent-supervisor benchmark even when the supervisor is self-interested by adopting this regulatory arrangement.

□

Appendix B

Multiple Levels of Bank's Riskiness

Suppose that there are N possible levels of risk. A bank's level of risk is denoted by $r \in \{r_1, r_2, ..., r_N\}$, with $r_i < r_j$ for any $i < j$. Denote by α_i the probability that $r = r_i$ with $\alpha_i \in (0,1)$ for all i and $\sum_{i=1}^{N} \alpha_i = 1$.

As before, the supervisor observes a signal correlated with the bank's true level of risk. The signal σ can be either informative, i.e. $\sigma = r$ with probability $\varepsilon > 0$, or uninformative, i.e. $\sigma = \emptyset$ with probability $1 - \varepsilon$.

Benchmarks

When there is a benevolent supervisor, the regulatory contract also depends on the supervisor's report and may entail a payment to the supervisor w. Salaries, banks' profits, and levels of capital put at risk are functions of both the supervisor's report, m_s, and the banker's message, m_b. Namely, the regulatory contract is a triple $\{k_i(m_b, m_s), \pi_i(m_b, m_s), w_i(m_b, m_s)\}$. As in the two level of risk case, when the supervisor is benevolent, the FSC need not pay a positive wage to the supervisor to avoid capture and induce truthful revelation of the signal. Therefore, a banker whose bank's level of risk is not the highest collects a rent only if $\sigma = \emptyset$. This allows the FSC to mitigate the distortion of the levels of capital put at risk by the banks. The FSC maximizes Equation (5) subject to $(IC_i^{\emptyset})$, (PC_i^i),$(PC_i^{\emptyset})$ and the supervisor's participation constraints. The following Lemma characterizes the optimal contract when the supervisor is benevolent.

Lemma 6. *The optimal contract when the supervisor is benevolent entails the following salaries for the supervisor:* $w_i^{\emptyset} = w_i^i = 0$ *for* $i = 1, ..., N$*. The banker's utility is* $B_i^i = 0$*, for* $i = 1, ..., N$*,* $B_j^{\emptyset} = B_{j+1}^{\emptyset} + \Delta r_{j+1} k_{j+1}^{\emptyset}$*, for* $j = 1, 2, ...N - 1$ *and* $B_N^{\emptyset} = 0$*. The bank's required levels of capital at risk are such that* $\Psi'(k_i^i) = (1 + \lambda) r_i$ *for* $i = 1, ..., N$*,* $\Psi'(k_1^{\emptyset}) = (1 + \lambda) r_1$*,* $\Psi'(k_j^{\emptyset}) = (1 + \lambda) r_j + \frac{\sum_{i=1}^{j-1} \alpha_i}{\alpha_j} \lambda \Delta r_j$*, for* $j = 2, ..., N$*.*

Proof. As the supervisor is benevolent, she will not receive a rent at the optimum. Hence her participation constraint always binds. The banker's participation constraint always binds when the signal is informative, i.e. (PC_i^i) bind for all $i = 1, ..., N$. The banker with the highest level of risk cannot attain any positive rent, even when the signal is not informative, i.e. $(PC_N^{\emptyset})$ binds. To minimize the rent given up to the banker in the other states, $(IC_i^{\emptyset})$ binds at the optimum. The FSC's maximization problem can then be rewritten as follows:

$$W = \max_{\{k_i^i\}, \{k_i^{\emptyset}\}} \varepsilon \sum_{i=1}^{N} \alpha_i \left(\Psi(k_i^i) - (1 + \lambda) r_i k_i^i \right)$$
$$+ (1 - \varepsilon) \sum_{i=1}^{N} \alpha_i \left(\Psi(k_i^{\emptyset}) - \lambda \left[\sum_{j=i+1}^{N} \Delta r_j k_j^{\emptyset} \right] - (1 + \lambda) r_i k_i^{\emptyset} \right)$$

whose first-order conditions yield the values of capital reported in the Lemma.

□

In the absence of a supervisor, the regulatory contract is $\{k_i(m_b), \pi_i(m_b)\}$ where m_b is the self-reported level of risk of a banker. The financial stability committee must set both participation and incentive compatibility constraints to induce the bankers to accept a regulatory contract and to report truthfully the level of risk of their bank:

$$B_i = \pi_i - r_i k_i \geq 0 \qquad (PC_i)$$

for all $i \in \{1, ..., N\}$ and

$$B_i = \pi_i - r_i k_i \geq \pi_j - r_i k_j = B_{ij} \qquad (IC_{ij})$$

for all $i, j \in \{1, ..., N\}$.

Since monotonicity holds, then we can focus on local incentive compatibility contraints only:

$$B_i = \pi_i - r_i k_i \geq \pi_{i+1} - r_i k_{i+1} = B_{i+1} + \underbrace{(r_{i+1} - r_i)}_{\Delta r_{i+1}} k_{i+1} \tag{IC_i}$$

The FSC can choose the levels of capital and, indirectly, the bankers' utility levels to maximize social welfare:

$$\sum_{i=1}^{N} \alpha_i [\Psi(k_i) - \lambda B_i - (1+\lambda) r_i k_i]$$

As a result, (i) every banker but the one whose bank has the highest risk obtains a rent in equilibrium; (ii) the level of capital of each bank is distorted away from efficiency, with the exception of the one whose level of risk is the lowest. The distortion of bank i's capital depends positively on λ, the difference in the risk level with $i-1$, and the cumulative probability that the bank has a lower levels of risk, i.e. $\sum_{j=1}^{i-1} \alpha_j$, whereas it depends negatively on α_i.

Lemma 7. *In the optimal no supervision contract, the banker's utility is $B_i = B_{i+1} + \Delta r_{i+1} k_{i+1}$ for $i = 1, ..., N-1$ and $B_N = 0$. The optimal levels of capital put at risk are:*

$$\Psi'(k_1) = (1+\lambda) r_1$$

and

$$\Psi'(k_i) = (1+\lambda) r_i + \frac{\sum_{j=1}^{i-1} \alpha_j}{\alpha_i} \lambda \Delta r_i \text{ for } i = 2, ..., N.$$

Proof. Since at the optimum PC_N and IC_i bind for all $i = 1, ..., N-1$, the FSC's maximization problem becomes:

$$\max_{k_1,...,k_N} \sum_{i=1}^{N} \alpha_i \left(\Psi(k_i) - \lambda \left[\sum_{j=i+1}^{N} \Delta r_j k_j \right] - (1+\lambda) r_i k_i \right)$$

First-order conditions yield the values of capital reported in the Lemma.

□

Proof of Lemma 4

The proof is similar to that of Lemma 3. All the capture incentive compatibility constraints and the incentive compatibility constraints bind at the optimum. Therefore, the FSC need not pay the supervisor a rent when the signal is not informative or when the banker could not earn anything by capturing the supervisor, namely when the level of risk is the highest. However, the supervisor must receive a rent to reveal information when the signal is informative and the bank's risk level is not the highest. Along similar lines, the banker need not receive a rent when the signal is informative or when the signal is uninformative but the level of risk is the highest. In contrast, the banker expects to receive some positive surplus when the signal is not informative and the level of risk is not the highest. The FSC's maximization problem can thus be rewritten as a function of $k_i^{\emptyset}$ and k_i^i:

$$W = \max_{\{k_i^i\},\{k_i^{\emptyset}\}} \varepsilon \sum_{i=1}^{N} \alpha_i \left(\Psi(k_i^i) - \lambda\tau \left[\sum_{j=i+1}^{N} \Delta r_j k_j^{\emptyset} \right] - (1+\lambda) r_i k_i^i \right)$$
$$+ (1-\varepsilon) \sum_{i=1}^{N} \alpha_i \left(\Psi(k_i^{\emptyset}) - \lambda \left[\sum_{j=i+1}^{N} \Delta r_j k_j^{\emptyset} \right] - (1+\lambda) r_i k_i^{\emptyset} \right)$$

whose first-order conditions yield the values of capital reported in the Lemma.

□

Proof of Proposition 2 The proof is similar to that of Proposition 1. The (IC_i^0) bind at the optimum for all $i = 1, ..., N-1$, and so do the (PC_i^i) for all $i = 1, ..., N$ and $(PC_N^\varnothing)$. As a result, $B_i^0 = B_i^i = B_N^\varnothing = 0$. The supervisor's participation constraints also bind and so do all the (CIC_i), which affect the salaries the supervisor receives off-the-equilibrium path. The $(IC_i^\varnothing)$ bind at the optimum and imply that $B_i^\varnothing = B_{i+1}^\varnothing + \Delta r_{i+1} k_{i+1}^\varnothing$ for $i = 1, ...N-1$. As a result, the FSC's maximization program becomes:

$$\begin{aligned} W =& \varepsilon \sum_{i=1}^{N-1} \alpha_i \left(\Psi(k_i^0) - (1+\lambda) r_i k_i^0 \right) \\ &+ \varepsilon \alpha_N \left(\Psi(k_N^N) - (1+\lambda) r_N k_N^N \right) \\ &+ (1-\varepsilon) \sum_{i=1}^{N} \alpha_i \left(\Psi(k_i^\varnothing) - \lambda \left[\sum_{j=i+1}^{N} \Delta r_j k_j^\varnothing \right] - (1+\lambda) r_i k_i^\varnothing \right) \end{aligned}$$

whose first-order conditions yield the values of capital reported in the proposition. Off the equilibrium path the FSC can set $\Psi'(k_i^i) = (1+\lambda) r_i$ for $i = 1, ..., N-1$, without loss of generality. Finally, notice that both $(IC_{\varnothing,i}^0)$ and $(IC_{j,i}^0)$ hold. A banker who knows that the signal is informative and whose level of risk is not the highest will choose the supervisor-free option designed for him. In contrast a banker who knows that the signal is not informative will prefer to be subjected to direct supervision.

□

Soft Information

Proof of Lemma 5.

First note that (CIC24) and (CIC) imply (CIC14). Intuitively, the coalition has no incentive to forge evidence of high riskiness in state 1 when it is already unprofitable to do so in state 2.
The FSC maximizes 3 subject to (CIC), (IC23), (CIC24), (PCi), (SPCi) for all $i = 1, 2, 3, 4$.
Note that the FSC can prevent collusion by rewarding the supervisor when she reports $m_s = \varnothing$ and the banker reports $m_b = \underline{r}$. This is achieved by imposing the following capture-incentive compatibility constraint:

$$w_2 - w_4 \geq \tau[B_4 - B_2 + \Delta r k_4] \qquad \text{(CIC24)}$$

As a result, the FSC gives up a rent to the banker only in state 2, i.e. $B_2^{mss} = \Delta r k_3^{mss}$, whereas $B_1^{mss} = B_3^{mss} = B_4^{mss} = 0$ because the participation constraint binds in the other states. The supervisor receives the following salaries:

- $w_4^{mss} = 0$ since the supervisor's participation constraint binds. Note that the supervisor need not receive a positive compensation to report that the bank is high-risk;
- $w_2^{mss} = \max\{\tau \Delta r (k_4^{mss} - k_3^{mss}), 0\}$. This is obtained from (CIC_{24}) once we replace B_2^{mss}, B_4^{mss}, w_4^{mss} with their optimal values, and from the supervisor's participation constraint in state 2;

- to satisfy (CIC), the FSC sets

$$w_1^{mss} = w_2^{mss} + \tau B_2^{mss} = \max\{\tau\Delta r(k_4^{mss} - k_3^{mss}), 0\} + \tau\Delta r k_3^s; \tag{COND}$$

- finally $w_3^{mss} = 0$ whenever $k_2 > k_4$. To see why this is the case, consider that it does not create an incentive for the banker-supervisor coalition to collude to report $m_s = \emptyset$ and $m_b = \underline{r}$ in state 3. Note that the supervisor would be willing to pay as much as w_2^{mss} to persuade the banker to misreport risk. The banker in state 3 would accept the supervisor's maximum bribe if and only if:

  $$\tau w_2^{mss} + \pi_2^{mss} - \bar{r}k_2^{mss} \geq \pi_3^{mss} - \bar{r}k_3^{mss}$$

  Note that the right-hand side is $B_3^{mss} = 0$ and the above can be rewritten as:

  $$\tau^2\Delta r(k_4^{mss} - k_3^{mss}) + B_2^{mss} - \Delta r k_2^{mss} \geq 0$$

  Since $B_2^{mss} = \Delta r k_3^{mss}$,

  $$\tau^2\Delta r(k_4^{mss} - k_3^{mss}) - \Delta r(k_2^{mss} - k_3^{mss}) \geq 0$$

  which is never satisfied since we assume $k_2 > k_4$. Below we show that this always holds at the optimum.

The required bank's levels of capital at risk in the case in which (COND) is satisfied for $k_4 > k_3$ are determined after plugging into (3) the salaries and the banker's utilities:

$$\begin{aligned}\max_{k_i, i\in\{1,2,3,4\}} W =& \alpha\varepsilon[\Psi(k_1) - (1+\lambda)\underline{r}k_1 - \lambda(\tau\Delta r k_4)] + \alpha(1-\varepsilon)[\Psi(k_2) - (1+\lambda)\underline{r}k_2 - \lambda\Delta r k_3(1-\tau) - \lambda\tau\Delta r k_4] \\ &+ (1-\alpha)(1-\varepsilon)[\Psi(k_3) - (1+\lambda)\bar{r}k_3] + (1-\alpha)\varepsilon[\Psi(k_4) - (1+\lambda)\bar{r}k_4]\end{aligned}$$

from which we can derive the following first-order conditions:

$$\begin{aligned}\frac{\partial W}{\partial k_1} &= 0 \Leftrightarrow \Psi'(k_1^{mss}) = (1+\lambda)\underline{r} \\ \frac{\partial W}{\partial k_2} &= 0 \Leftrightarrow \Psi'(k_2^{mss}) = (1+\lambda)\underline{r} \\ \frac{\partial W}{\partial k_3} &= 0 \Leftrightarrow \Psi'(k_3^{mss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}\lambda(1-\tau)\Delta r \\ \frac{\partial W}{\partial k_4} &= 0 \Leftrightarrow \Psi'(k_4^{mss}) = (1+\lambda)\bar{r} + \frac{\alpha}{(1-\alpha)\varepsilon}\lambda\tau\Delta r\end{aligned}$$

Note that (i) k_2 is always greater than k_4 and (ii) this solution holds only as long as $k_4 > k_3$, that is when $\Psi'(k_3) > \Psi'(k_4)$, which requires:

$$\frac{\varepsilon}{1+\varepsilon} > \tau$$

that is τ sufficiently small. When the above inequality is not satisfied, $w_2^{mss} = 0$ and k_3^{mss} should be (weakly) greater than k_4^{mss}.

However, since it is inefficient to distort k_4 away from efficiency more than k_3, the best the FSC can do is to set $k_4 = k_3 = k_j$.
Therefore, $B_2^{mss} = \Delta r k_j$. The FSC chooses k_1^{mss}, k_2^{mss}, k_j^{mss} to maximize the following program once the optimal level of the supervisor's salary and bank's profits are plugged into (3):

$$\max_{k_i, i \in \{1,2,j\}} W = \alpha\varepsilon[\Psi(k_1) - (1+\lambda)\underline{r}k_1 - \lambda(\tau\Delta r k_j)] + \alpha(1-\varepsilon)[\Psi(k_2) - \lambda(\Delta r k_j) - (1+\lambda)\underline{r}k_2]$$
$$+ (1-\alpha)[\Psi(k_j) - (1+\lambda)\bar{r}k_j]$$

from which we can derive the following first-order conditions:

$$\frac{\partial W}{\partial k_1} = 0 \Leftrightarrow \Psi'(k_1^{mss}) = (1+\lambda)\underline{r}$$
$$\frac{\partial W}{\partial k_2} = 0 \Leftrightarrow \Psi'(k_2^{mss}) = (1+\lambda)\underline{r}$$
$$\frac{\partial W}{\partial k_j} = 0 \Leftrightarrow \Psi'(k_j^{mss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}[1 - \varepsilon(1-\tau)]\lambda\Delta r$$

The distortion of the bank's required level of capital in states 3 and 4 reflects the trade-off existing between efficiency and the rent the FSC gives up to the bank in state 2 and to the supervisor in state 1. In contrast, the FSC can impose the first-best level of capital in the other states of the world.

□

Intuitively, when information is soft there are two alternative policies the FSC can follow to prevent capture. The first is to destroy the incentives of the banker-supervisor coalition to strike a side agreement by rewarding the supervisor in state 2. This makes it irrational for the supervisor to manipulate evidence with the cooperation of the banker and report that the state is 4. The second is to destroy the incentives of the banker to capture the supervisor by making the low risk banker in state 2 unwilling to mimic the banker in state 4 even if it were possible without the cooperation of the supervisor, i.e., if the supervisor could be captured at no cost.
A simple application of the Envelope Theorem shows that welfare is strictly decreasing in τ.

Proof of Proposition 3

We first determine which constraints bind at the equilibrium. At the optimum, the banker's participation constraints in states $1, 3, 4$ and when he chooses the supervision-free option 0 must bind. Formally we have

$$\pi_i^{fss} = k_i^{fss} r_i$$

for $i \in \{0, 1, 3, 4\}$. The profit in state 2 must satisfy (IC23), hence:

$$\pi_2^{fss} = \underline{r}k_2^{fss} + \Delta r k_3^{fss}$$

In contrast with Proposition 1, only w_3^{fss} and w_4^{fss} can always be set equal to zero. Whereas, akin to the mandatory supervisory case, the FSC finds it optimal to discourage the additional capture concerns by setting both $w_1^{fss}, w_2^{fss} > 0$ only when τ is small enough.[34] When this is the case, preventing forgery of evidence by rewarding the supervisor in equilibrium is not overly costly and, as a result, the FSC can distort k_4^{fss} less than k_3^{fss}.
To satisfy (CIC24), the FSC sets $w_2^{fss} = \tau\Delta r(k_4^{fss} - k_3^{fss})$ and, to satisfy (CIC), the FSC promises $w_1^{fss} = \tau\Delta r k_4^{fss}$, which is never paid in equilibrium.
This leads to the following program:

$$\max_{k_i, i\in\{0,2,3,4\}} W = \alpha\varepsilon[\Psi(k_0) - (1+\lambda)\underline{r}k_0] + \alpha(1-\varepsilon)[\Psi(k_2) - (1-\tau)\lambda(\Delta r k_3) - \lambda\tau\Delta r k_4 - (1+\lambda)\underline{r}k_2]$$
$$+ (1-\alpha)(1-\varepsilon)[\Psi(k_3) - (1+\lambda)\bar{r}k_3] + (1-\alpha)\varepsilon[\Psi(k_4) - (1+\lambda)\bar{r}k_4]$$

Maximization with respect to k_i, for $i = 0,2,3,4$ yields the following first-order conditions:

$$\frac{\partial W}{\partial k_0} = 0 \Leftrightarrow \Psi'(k_0^{fss}) = (1+\lambda)\underline{r}$$
$$\frac{\partial W}{\partial k_2} = 0 \Leftrightarrow \Psi'(k_2^{fss}) = (1+\lambda)\underline{r}$$
$$\frac{\partial W}{\partial k_3} = 0 \Leftrightarrow \Psi'(k_3^{fss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}(1-\tau)\lambda\Delta r$$
$$\frac{\partial W}{\partial k_4} = 0 \Leftrightarrow \Psi'(k_4^{fss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}\frac{(1-\varepsilon)}{\varepsilon}\tau\lambda\Delta r$$

Without loss of generality we can set $\pi_1^{fs} = \underline{r}k_1^{fs}$ with k_1^{fs} satisfying the equation $\Psi'(k_1^{fs}) = (1+\lambda)\underline{r}$.
The banker of a high-risk bank never chooses the non-supervision option whereas the banker of a low-risk bank prefers to be supervised when he knows that the supervisor collects uninformative evidence so as to earn a positive rent.
However, this solution holds only has long as $k_4 > k_3$, that is when $\tau < \varepsilon$.
When this condition is not satisfied, the best the FSC can do is to set $k_4^{fss} = k_3^{fss} = k_j^{fss}$. As a result, there are no reasons to reward the supervisor in state 2.

[34] Recall that the FSC does not want to induce the low-risk banker to opt for Flexible Supervision also when the supervisor's signal is uninformative. While this would allow the FSC to save w_2^{fss} (which then would be paid only off-the-equilibrium path) it would destroy the benefits of screening as the low-risk banker should be allocated the same rent in states 1 and 2 and the no-supervision outcome would be achieved.

Therefore, $B_2^{mss} = \Delta r k_j$. The FSC chooses $k_1^{fss}, k_2^{fss}, k_j^{fss}$ to maximize the following program:

$$\max_{k_i, i \in \{0,2,j\}} W = \alpha\varepsilon[\Psi(k_0) - (1+\lambda)\underline{r}k_0] + \alpha(1-\varepsilon)[\Psi(k_2) - \lambda(\Delta r k_j) - (1+\lambda)\underline{r}k_2]$$
$$+ (1-\alpha)[\Psi(k_j) - (1+\lambda)\bar{r}k_j]$$

from which we can derive the following first-order conditions:

$$\frac{\partial W}{\partial k_0} = 0 \Leftrightarrow \Psi'(k_0^{fss}) = (1+\lambda)\underline{r}$$
$$\frac{\partial W}{\partial k_2} = 0 \Leftrightarrow \Psi'(k_2^{fss}) = (1+\lambda)\underline{r}$$
$$\frac{\partial W}{\partial k_j} = 0 \Leftrightarrow \Psi'(k_j^{fss}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}[1-\varepsilon]\lambda\Delta r$$

Again, it is without loss of generality to set $\pi_1^{fs} = \underline{r}k_1^{fs}$ with k_1^{fs} satisfying the equation $\Psi'(k_1^{fs}) = (1+\lambda)\underline{r}$.
□

Akin to the hard information case, implementing Flexible Supervision always improves welfare with respect to Mandatory Supervision. However, in the presence of soft information, the greater set of capture possibilities obliges the FSC to distort k_4 from its efficient level, in so preventing the achievement of the *benevolent-supervisor* level of welfare.
A simple application of the Envelope Theorem shows that welfare is strictly decreasing in τ if $\tau < \varepsilon$ and does not change with τ when $\tau \geq \varepsilon$.

Differently-Skilled Supervisors

In Section 4.4 we have shown how the Flexible Supervision should be profitably tailored in a scenario in which the banker is initially unaware as to the skills of the supervisor who will be sent to check the bank's riskiness. In particular, we have focused on a polar situation wherein the supervisors can be either high or low skilled and only in the former case they can learn (perfectly) the bank's level of risk.
As noted in the paper, this setting is isomorphic to one in which there is only one type of supervisor who, as in the first part of the model, learns r with probability ε, and the banker is initially unaware of what signal she will observe. With this different information timing, the sequence of events is as follows:[35]

1. The supervisor observes the signal. The banker learns the bank's riskiness. The probability distributions are common knowledge.

[35]Burlando and Motta (2015) use this time structure in the context of the optimal organization of a firm in the presence of corruption concerns.

2. The FSC simultaneously proposes a regulatory-supervisory contract to the supervisor and the banker. If the banker does not accept the contract, the game ends and all players receive their reservation utilities. If only the banker accepts the contract, the bank's profit π and level of capital k will be contingent solely on m_b. If both the banker and the supervisor participate, the game continues as follows:
3. The banker learns the signal σ.
4. The banker and the supervisor can privately sign a side-contract.
5. The banker and the supervisor send their messages to the financial stability FSC. The regulatory-supervisory contract is implemented according to their reports.

In addition to the assumptions made in the baseline model, we further impose that the banker is able to quit the game at any time. As shown in the paper, when the Flexible Supervision is implemented, the constraints that must be fulfilled to ensure that there is an optimal separation of banks at stage 2 are that the low-risk bankers opt for the supervision-free contracts:

$$\pi_0 - \underline{r}k_0 \geq \varepsilon(\pi_1 - \underline{r}k_1) + (1-\varepsilon)(\pi_2 - \underline{r}k_2)$$

whilst the high-risk bankers choose to be inspected:

$$\varepsilon(\pi_4 - \bar{r}k_4) + (1-\varepsilon)(\pi_3 - \bar{r}k_3) \geq \pi_0 - \bar{r}k_0$$

The constraints hold in expectation because the banker knows the riskiness of his bank but does not know with certainty which state he is in.

It is then possible to show that the Optimal Flexible Supervision with this alternative timing entails the following profits and capital requirements in equilibrium $\pi_0^{lr2} = \underline{r}k_0^{lr2} + (1-\varepsilon)\Delta r k_3^{lr2}$, $\pi_3^{lr2} = \bar{r}k_3^{lr2}$, $\pi_4^{lr2} = \bar{r}k_4^{lr2}$, $\Psi'(k_0^{lr2}) = (1+\lambda)\underline{r}$, $\Psi'(k_3^{lr2}) = (1+\lambda)\bar{r} + \frac{\alpha}{1-\alpha}\lambda\Delta r$, $\Psi'(k_4^{lr2}) = (1+\lambda)\bar{r}$. The supervisor is paid $w_i^{lr2} = 0$ for $i \in \{3,4\}$. Off-the-equilibrium path, $\pi_1^{lr2} = \underline{r}k_1^{lr2}$, $\pi_2^{lr2} = \underline{r}k_2^{lr2} + \Delta r k_3^{lr2}$, $\Psi'(k_1^{lr2}) = \Psi'(k_2^{lr2}) = (1+\lambda)\underline{r}$ $w_1^{lr2} = \tau\Delta r k_3^{lr2}$, $w_1^{lr2} = 0$.

Note that with this different information timing, the timing of negotiations is critical. If the FSC negotiated first with the banker and then with the supervisor, Flexible Supervision could not profitably be implemented: for the choice of whether or not to be subjected to supervision would be type-revealing, the FSC would never benefit from hiring the supervisor. Anticipating this, the banker would always opt for supervision so as to collect an informational rent in some states of the world.

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